PRACTICAL JAPANNING · AND · ENAMELING

By WILLIAM J. MISKELLA, M.E.

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PRACTICAL JAPANN
AND ENAMELIN

(*BAKED FINISHING*)

BY

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A HANDBOOK
ON MODERN METAL FINISHING

Including Information on Gas-meters, Heat Insulat
Rubbing Machines, Sand-blasting, Thermometers, Sp
Finishes, Metal Cleaning, Mechanical Decoration,
Stencils, New Application Methods, Lithographing
Water Japanning.

PRACTICAL FINISHING SERIES
Volume III

A Companion to

Volume I. Practical Color Simplified

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FOREWORD

It shall be the policy of the publishers of the PRACTICAL FINISHING SERIES to furnish readers with the very latest and most concrete information on the subject of Finishing. The information contained herein is presented in such a way that the reader not experienced in looking for reliable information in books and libraries will have no difficulty in locating matter covering the point in question.

This particular book contains all the latest information on Baked Finishing and with Volume I, PRACTICAL COLOR SIMPLIFIED, places in the hands of the user, in compact and simple form, just what he needs to obtain a comprehensive knowledge of the entire subject.

The publishers, as well as the author, welcome the cooperation and help of all material and equipment manufacturers as well as individuals interested in Finishing. They have, however, in this book departed from a custom that has grown up in the book publishing business—that of giving special credit or making special mention of any company or individual for the use of photographs, cuts, and so on. Therefore, in justice to all it will be the policy not to make special mention of such assistance.

However, this work would never be a reality if it were not for the kind assistance of many others.

WILLIAM J. MISKELLA

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I

INTRODUCTION

What Is Japanning?
Oriental Lacquers
Japanese Varnish
Japan Varnish
The Daily Shop Routine
Carrying in the Work
There Was an Explosion Hazard
A Small Gas Main Handicapped Us
Progress Bewilders One
The Quality of the Finish
Tests of Japanned Articles
New Uses

What Is Japanning? That question has been asked many times during the past 20 years and there have been many strange answers—some good—some questionable. In fact, it was not until after many months of research and reading that a plausible explanation of japanning was apparent.

The little literature that is to be found on the subject is so confused with other subjects and there are so many conflicting statements about the materials and processes used in japanning that it is difficult indeed to select those that may be taken as authentic. No doubt a reason for this is the custom of men, who know how to handle and use japan, to keep secret whatever knowledge they have gained. Indeed, it is evident that some of them have even lied about the facts to inquisitive persons in order that the truth might be concealed as long as possible.

There is no other material just like japan in its make-up. It really is a marvelous material and is not well enough known to get the credit it justly deserves. It could be defined as a process of applying a mineral coating to metals—a coating that deteriorates less with age than any other known material that is applied in liquid form. It looks like paint and is often erroneously called paint; yet, it is as unlike paint as water is unlike oil.

Paint is a coating material made up of a pigment which gives it color, a drying oil which gives it life, and a reducer which conditions it so that it may be applied readily. The duration of the existence of a paint film rests with the life of the drying oil—when that ends the paint disintegrates and falls off, all of which happens within a few years on an average.

Japan also contains a drying oil, but oxidization is accelerated while the articles coated with it are baking inside of the japanning oven. The heat does not affect the pigment—a member of the asphalt family called gilsonite—and to make a long story short, the process consists of simply transferring a coating of mineral gilsonite from the mine in the ground to the surface of the article that is being finished. The heat in the japanning oven causes the material, which is obtainable in a variety of black shades, to flow together in a beautiful, smooth, uniform coat.

The result is the most durable and highly satisfactory metal coating in existence—when it is applied properly. Of course, it is always *black*. Some examples are: automobile fenders, adding machines, and typewriters. It is the cheapest known metal finish from the standpoint of cost and by far the most durable, not excepting nickel-plating, pyroxylin lacquer or spar varnish. It cannot be applied to wood or any material that will not stand being baked at a minimum of 325 degrees F. *All materials that are applied and baked at temperatures below that temperature are not japans.*

Naturally, one would infer from the name that the idea started in Japan, but evidently it did not. It is recorded that in the beginning of the third century the Japanese made an expedition to Korea, which was then a Chinese possession, and took back to Japan the lac tree which they naturalized in Japan and commercialized there.

ORIENTAL LACQUERS are produced from the sap of the lac tree. They are marketed under many different names; Chinese, Japanese, Foochow, Pekin, Cinnabar, and so on. The reader is especially cautioned against confusing this kind of lacquer, which, by the way, is known as oriental lacquer, with the popular finishing material that we hear and read so much about today, known as nitrocellulose, or pyroxylin lacquer. The latter is a chemical composition—an American invention—made from cotton and corn raw materials. The origin of the idea of japanning lies in the oriental lacquer referred to above, in spite of the fact that the two materials are in no way related and there is no connection whatever with the pyroxylin lacquers.

Dr. A. H. Sabin, author of "Industrial and Artistic Paint and Varnish," one of this country's greatest authorities upon the history of painting materials, supports the theory that the lac tree came from China. Dr. J. J. Rein, professor of geography in the University of Bohn, who spent some time in Japan about 1889, studying industries there, at the expense of the German government, also supports this theory.

JAPANESE VARNISH was obtained from the tree known as *Rhus Vernici Ferv*—a tree very similar to the American Sumac. After the Japanese imported this tree from Korea they gave it the name—*Winni Naki.* These trees grow about 30 feet high and at the age of 40 years have a trunk measuring 40 inches in diameter. The liquid produced is called lac, but it must not be confused with shellac or shell-lac which is formed from the excretion and shells or bodies of an insect.

European japanners did not have the patience to follow the Japanese oriental lacquering process where it was customary to apply 30 or 40 coats over a period of six months and so they started to make imitations using copal varnish, and of course, reduced the number of coats.

About the middle of the eighteenth century both the Chinese and the Japanese were making varnishes out of lac. These were first called Japanese varnish and later Japan varnish. Still later the noun was dropped from Japan varnish and finally, the adjective "japan" became a noun by common use. *There is, however, no similarity between the oriental lac material and modern japan—only the name.*

JAPAN VARNISH is used in one of the oldest United States patents, taken out by John J. Howe and Truman Piper of Derby, Connecticut, June 10, 1856, and was assigned to the Howe Mfg. Co. of that city. This interesting patent covers the japanning of pins and reads just as if it were taken out yesterday, with the exception that the old term, Japan varnish, was used in place of the modern term, japan.

THE DAILY SHOP ROUTINE of 20 years ago, was to bake black-coated metal parts for at least four hours, regulating the open flame oven as well as one could without the use of any kind of a recording instrument. In those early days, I was forced to stay in the shop many a night long after midnight waiting for one and sometimes all of the 16 ovens that we had in use at the time to get up to 350 degrees F., which was considered the very minimum point to reach before one could safely shut off the gas and leave for the night with the assurance that if the ovens were closed up tight and the heat held in them, the loads would be, not properly, but passably baked the following morning.

It was the custom to spend the morning period up to noon in unloading the work that was put into the japanning ovens on the previous afternoon. The workmen all left at five p.m., and the night watchman remained to bake-off the ovens. As a reward for close attention to his job, he was allowed to go home whenever he succeeded in properly baking all of the ovens. Occasionally, an oven would be found that was not baked hard enough. This would cause a serious delay the following day until the contents of that particular oven was again baked and carried through the cycle.

Very often when the condition of the atmosphere outside was close, the smoke from those 16 ovens would not pass out through the small chimney that had an inside cross-sectional area of about 32 square inches. The result would be that the smoke fumes from this battery of japanning ovens would be so thick that one could not see a foot ahead.

Figure 1—A JAPAN SHOP IN 1895

In those early days (Figure 1) we used to go through things that we consider great hardships today. We went about our work mechanically and did things because those who had gone before us had done them. Little thought was given to the reason that caused the watchman to finish his job one night at nine o'clock only to be forced to stay until four o'clock in the morning at another time. We never wondered why such an effort had to be made to regulate the heat aside from the fact that we had been advised that was the proper procedure.

We were really not as ignorant as we might appear to a user of the modern japanning equipment. In the first place, we had a small gas intake from the street. The size of that used for our 16 miscellaneous ovens was only two inches inside diameter! We might place two tons of castings in a single oven heated by means of two open-flame gas-burners less than six feet in length. How would it be possible to get the heat of this mass up to 375 degrees F., with all the other 15 ovens connected to the same gas supply?

Naturally, our only salvation was to "give all the gas" to the heavy load and get rid of it and then exert our energy on the remaining ovens.

Carrying in the Work on rods and trays was the practice and, after the heat was over, a workman had to go into the oven empty handed and carry out a few pieces at a time. Imagine the frightful loss of labor under such a system.

Today, instead of having men walk in and out of the oven carrying the work in small lots, the entire load is carried out on an intermittent conveyor, a wheel truck or on a continuous conveyor, thus saving all this labor that used to be a total loss.

There Was an Explosion Hazard. We knew that japanning ovens were dangerous and that it would be well to watch every move that one made when around them. Occasionally one blew up and took a part of the building with it and all we knew about the cause was guesswork. Some thought the gas was the real cause, while others thought that the japanning material was the cause. We were intentionally kept as ignorant as possible by suppliers.

As users of japan material we were instructed by the manufacturer of the material to bake four hours up to 375 degrees F. We did not know what the material was made of and there was no way of finding out. Whenever any salesman or japanner was fortunate enough to get hold of a formula for japan, he usually dropped the japanning business and started in the japan manufacturing business. Thus it will be seen that there was a very strong effort on the part of the makers of japan to guard closely their formulae as well as the men who did their mixing, so that no competitor could learn any of their secrets.

But today we do not have to worry much about explosions. There are safety doors on all modern ovens and few ovens are being built that are of the old direct-fired type—the kind that earned the bad reputation for the japanning industry.

A SMALL GAS MAIN HANDICAPPED US because we threw too great a load of ovens on it at once, but today we do not have to worry about baking-off the ovens or even to have a night watchman. Instead of trying to do all the baking at one time from gas supplied through a small gas main, we bake the ovens as fast as they are filled one at a time during the day with gas supplied through a large gas main. In other words, our load is uniformly distributed throughout the day.

Also, modern ovens are equipped with regulation devices and recording thermometers which automatically draw the curve that we used to try to approximate by guesswork. Today we even have electric exhaust fans to take away the smoke fumes so that modern japanners hardly know that there was once such a thing as smoke fumes to contend with.

PROGRESS BEWILDERS ONE, for not long ago I stood watching the operation of our intermittent conveyor and I could not help marveling at the remarkable changes that had taken place. There was hanging on the conveyor a load of 160 automobile bumper bars ready to enter the oven as soon as the doors at the two ends opened. Inside the oven another load of 160 bumper bars was baking, and on the opposite end of the oven was still another load of the same amount being unloaded. Hanging on the conveyor, therefore, just as the oven was about to be "pulled," were 4,800 pounds of parts, all of which would be baked, unloaded, and in the shipping room *in less than one hour.* Think of it! Twenty years ago each one of those loads would take four hours to bake—now they take twenty minutes! Twenty years ago a load of similar parts would be received by us at noon of one day and would be delivered about noon of the following day—twenty-four-hour service. Today we receive a similar load of parts at eight o'clock in the morning and have them in the shipping room by ten o'clock—two-hour service.

THE QUALITY OF THE FINISH has been greatly improved by modern equipment. No doubt, individual pieces done in the old days could be selected to show wonderful japanning technique, but the continuous uniform results that modern improvements enable us to secure could not in any way have been equaled by the early japanners.

Tests of Japanned Articles may be made as severe as possible if the japan finish is applied to a properly cleaned surface with the proper kind of materials under the proper baking conditions.

The following specifications of the Department of Electricity of the City of Chicago covers ordinary metal conduit used for protecting electric wires. This item is found in almost every house and building in the land. (The word "enamel" has been changed to "japan," the proper term):

> All surfaces of the tube must be protected against corrosion by one of the following or some other approved methods:
>
> The japan coating on either the inside or the outside surface of the finished conduit must not soften at ordinary temperatures. It must have an even and smooth appearance and must be of a uniform quality at all points of the length of the tube. It must be of sufficient weight and toughness to resist smashing or flaking and must be of sufficient elasticity to prevent its cracking or flaking at any time up to one year from the month of manufacture when one-half inch conduit is bent in a curve, the inner edge of which has a radius of three and one-half inches.
>
> The japan coating must not be seriously affected by soaking at 70 degrees F. for 24 hours in any of the following aqueous solutions:
>
> 1. Sulphuric acid of 1.3 specific gravity containing 40% by weight of anhydrous sulphuric acid.
>
> 2. Commercial strong hydrochloric acid containing 20% by weight of anhydrous hydrochloric acid.
>
> 3. Acetic acid containing 20% by weight of anhydrous acetic acid.
>
> 4. Saturated solution of carbonate of soda, containing 20% by weight of anhydrous carbonate of soda.

From this it is evident that the specifications covering good japanning are very rigid. However, it is just as easy to meet them and do good work as it is to do the reverse.

New Uses for this most valuable finish include the protection of steam and hot water radiators. Instead of forcing the paint contractor to do an extra cleaning operation to remove the rust from the unfinished product, the manufacturers are now going to change all this and bake a protecting coat on radiators before shipping.

No more, therefore, will we see rusty piles of cast-iron parts in front of new buildings. It will be interesting to watch this idea develop. The reader will unconsciously notice it as time goes on.

Another interesting development is the finish of automobile rims. Experience has demonstrated that galvanized rims rust where the tire flap comes in contact with the periphery of the rim. Research discovered that a galvanized rim with a japan finish on it did not rust. That evolved the thought of cutting the cost of automobiles by omitting the *tire flap*. Further investigation suggested the omission of the galvanized coat. Thus, baked japan finishing is responsible for eliminating flaps from automobile tires—an enormous saving when one considers that approximately 25,000,000 tires are assembled annually on new automobiles.

II

RELATED MATERIALS AND PROCESSES

Japan Drier
Porcelain Enameling
Lacquer Enameling
Decorating the Surface
Crackle Finishes
Flake Finishes
Plastic Finishes
Veiling Lacquer

Japan Drier (also called japan driers, driers, japan) is a colorless liquid which itself dries to a hard film having considerable coherence. Its principal use is a vehicle for grinding coach painting colors. Colors are bought by the user, as, for example: red ground in oil, or red ground in japan; or, possibly, red ground in varnish. Colors ground in japan dry quicker than those ground in oil.

Why there should be so much misunderstanding among paint technology authorities and manufacturers about the difference between japan and japan driers is hard to understand for they are radically different. *It should be understood that japan drier does not enter into the formulae of baking japan in any way. Japan drier is used in air-dry paints to chemically hasten drying, while heat, through the medium of a japanning oven, is used to hasten the drying of baking japan.* To further explain this and to clear up the misunderstanding that exists it might be well to elaborate somewhat on *driers.*

The subject should not be touched on at all in this book, were it not for the fact that all japanners at some time or another have to do some air-dry painting. There are two general forms of paint driers; one is made from linseed oil and a drying salt such as cobalt or manganese; the other is a substitute for the former and is made of rosin instead of linseed oil. The linseed-oil drier is first boiled and then reduced with turpentine. In the poorer grades benzine is also included in the formula. The fact that the United States government will reject any drier containing rosin is sufficient.

The addition of drier to any kind of paint is considered detrimental and shortens the life of the coating. However, there are places where it must be used regardless of this fact. Paint consists of the following elements:

1. Pigment for color
2. Oil for vehicle
3. Reducer for conditioning
4. Drier to hasten hardening

The life of a coating depends entirely upon how long it takes the oil to harden (it may be one year or even several years). Soon after the oil is completely hardened the coating begins to deteriorate and finally begins to chalk. Therefore, the addition of driers to paints makes the outside film of the coating dry quickly, but sacrifices durability. Of course, the use of drier is a necessity where the paint is applied to a surface that is used a great deal; for example, on steps, or on the front of a store on a traffic street.

In any event, the proportion of the drier that one uses is very small, so it pays to use the very best. In general, one part of good drier to 20 parts of raw linseed oil in a paint will dry the coating in 12 hours under normal conditions. That is, the outer film of the coating will be dry to the touch. From this the reader will see that it is easily possible for the painter, usually through ignorance, to add *too much* drier.

To test the drier, mix well together an ounce of the sample and a quart of raw linseed oil. Place some of the mixture on a piece of clean clear glass, set upright and observe the length of time it takes to dry. If at the end of 36 hours it scales or comes off easily when scratched with a knife, it is poor.

The following list of substances enter into the manufacture of various driers, but only those in *italics* enter into the formula of *japan drier:*

Shellac gum
Kauri gum
Rosin black
Lead acetate
Cobalt
Litharge
Manganese dioxide
Lime
Borate of manganese
Linseed oil
Turpentine
Benzine
Raw umber
Burnt umber
Zinc sulphate
Red lead
Turpentine substitute
Petroleum oil
Rosin or colophony
Rosin oil
Nickel
Iron
Copper

Chemically, lead and manganese compounded with raw linseed oil form *japan drier* and impart to the oil, or varnish in which they are dissolved, the property of rapid oxidization. The compounds are made by heating as high as 600 degrees F. the oil and the oxides of lead or manganese. They are liquid when hot and solid when cold. The resultant combination is dissolved in turpentine while still warm. This compound not only has some of the drying properties of a varnish, but has the distinctive property of imparting quick drying to the paint or varnish, with which a small portion of it is mixed. The chemical action is described by Sabin as follows:

> The action of driers may be best understood by first describing a different but analogous process, the formation of white lead or carbonate of lead from metallic lead and the carbonic acid of the air. Carbonic acid readily attacks metallic lead, but a very thin film is formed of lead carbonate which protects the metal beneath. The sheet of metallic lead is, therefore, put, loosely rolled, in a jar with a very small quantity of acetate acid. This acid eagerly attacks the lead, forming lead acetate. Carbonic acid is a stronger acid than acetic and it, in turn, attacks the lead acetate, forming lead carbonate, and the acetic acid is set free to attack a fresh quantity of lead, and this process goes on until all the lead is converted. At the close we should theoretically have all the acetic acid we began with; in practice some of it evaporates.
>
> Driers act in a similar manner, taking up oxygen from the air and giving it up to the oil. These driers are compounds of lead and manganese, in solution in the oil; these metals have the power of forming two sets of oxygenated compounds, the peroxidized ones having twice as much oxygen as the others. When in the linseed oil they give up half their oxygen to the oil; then, being exposed to the air, they absorb a fresh equivalent of oxygen, which again the oil takes from them; in this way they act as carriers of oxygen from the air to the oil, acting, of course, only when the oil is spread out in a film and exposed to the air. Since the oil is thus converted into a solid dry substance these agents are called driers.

PORCELAIN ENAMELING is a vitreous process in which the finish is fused on at a high temperature at red heat. It is often confused with colored enameling.

LACQUER ENAMELING is likewise confused with baked color enameling. Both processes are performed similarly and reach a result that is similar. However, colored enamel is dried by baking in an oven, while lacquer enamel is air-dried.

DECORATING THE SURFACE of japanned and enameled parts is done in several ways, but the principal method used is *striping*.

Stencils, both common and compound, are used to a considerable extent and, of course, decalcomania transfers play an important part.

[All of these decorating methods are described in detail and profusely illustrated in PRACTICAL AUTOMOTIVE LACQUERING, Volume II, Chapter XII.

Please disregard the information covering striping with lacquer on a *japan* undercoat as it would not adhere properly. However, it will adhere and there is no objection to its use on *baked colored enamel* surfaces.]

CRACKLE FINISHES (Figure 2) have mystified many. They are produced with lacquers and require three operations:

1. An undercoat of lacquer
2. A crackle coat
3. Either a clear lacquer or a colored lacquer enamel

The first coat may be any color unless the final cracks as shown in the figure herewith are to be of a preferred color, in which case the *first coat* must be of that preferred color.

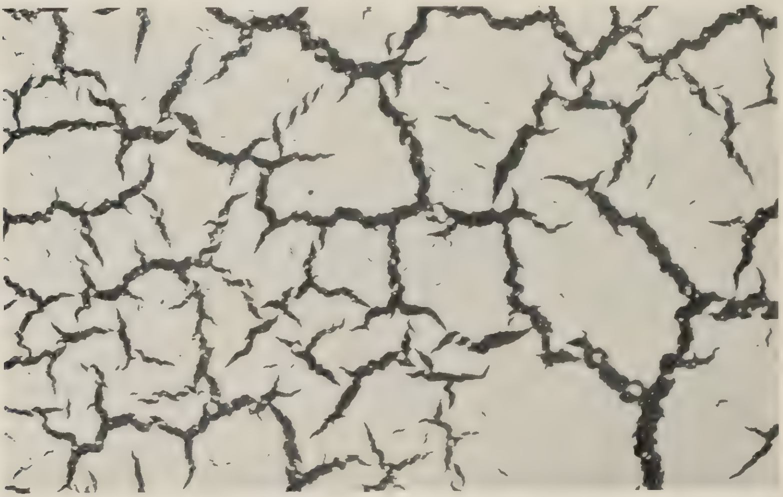

Figure 2—A SAMPLE OF A CRACKLE FINISH

The mysterious part of the finish is the contracting and breaking effect that takes place immediately after the second crackle coat is applied with a spray-gun.

However, when one realizes that the material used in this second operation is made up of thinner and pigment—principally thinner, and that the thinner or solvent acts upon the first coat by *penetration,* which causes a softening and contraction of the first coat, it is a simple matter to understand.

The inert pigment, of course, remains on the surface and does not penetrate. When the solvent action of the thinner in the second coat material is over, it will be found that the first coat has contracted and pulled here and there leaving visible the cracks from which the crackle finish gets its name. Finally, either a coat of clear or colored lacquer is applied and the task is over.

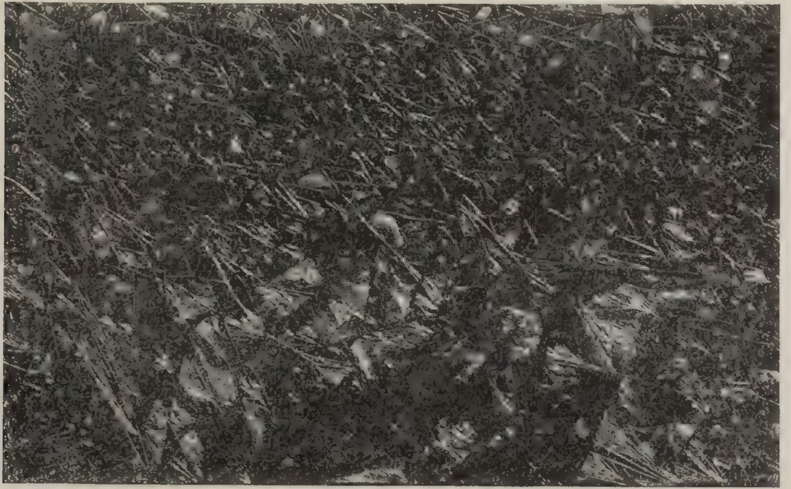

Figure 3—A SAMPLE OF A FLAKE FINISH

The above described effect may be proven by spraying some of the second coat material on a piece of glass or metal and noting that there is no separating effect. Also, one may use *an oil base material* such as varnish or an enamel as a first coat material, especially when very large checks are desired. A light or a heavy coat of the second material will also vary the size of the *checks.*

FLAKE FINISHES (Figure 3) are also produced with lacquer. They will work on glass or any hard surface like very hard baked japan,

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See Chapter IV, page 33, for other special finishes.

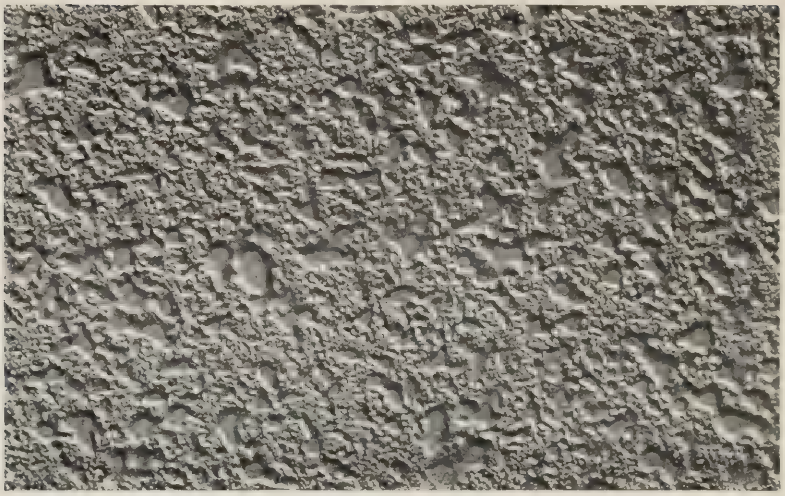

Figure 4—A Sample of a Coarse Plastic Finish

but not over lacquer or paint. In fact any porous surface as, for example, a rusty spot on steel will spoil the flake effect.

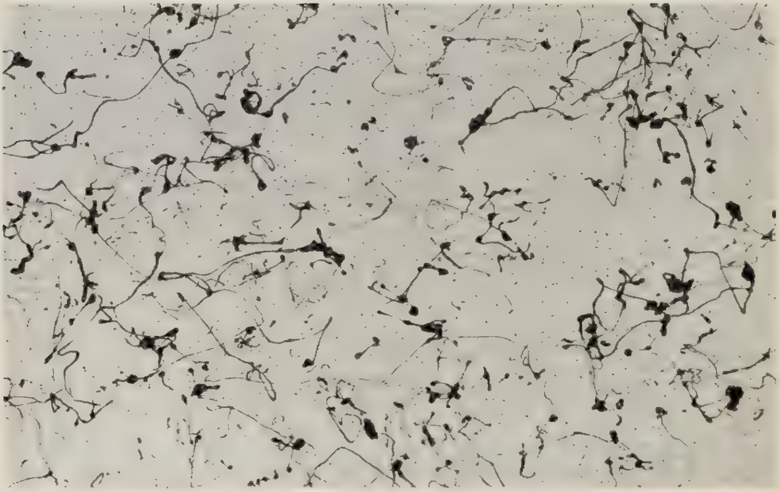

Figure 5—A Sample of Veiling Lacquer

Plastic Finishes in a great variety of effects all the way from very fine to extremely coarse (Figure 4) are produced by applying oil base plastic finishing material with a spray-gun equipped with a special nozzle and operated at low air pressure. A color coat on top creates a very pleasing finish.

Veiling Lacquer (Figure 5) or a web finish as its name indicates consists of a screen effect over a certain colored background. The web may be made in one color or in several colors. It may be made with a single hand spray or with a spray which applies three colors at one time. The web may be varied in mesh size also. The little knots at the web centers are characteristic of this finish.

III

RAW MATERIALS

Asphaltum
Pitches
Drying Oils
Raw Linseed Oil
Boiled Linseed Oil
Blown Linseed Oil
Soy Bean Oil
Sunflower Oil
Perilla Oil
Tung Oil
Japanners' Brown Oil
Raw China Wood Oil
Stand Oil
Resins
Copals
Damar
Rosin

The various raw materials entering into the making of japans and enamels have some interesting characteristics and it is well for the user to know something about them.

Asphaltum is the principal pigment used in the manufacture of *black japan* and *black* enamels. There are two principal grades (Table 1). Much of that mined in the United States is found in Utah and is the purest form of natural hydrocarbon. It is picked, screened, and sacked *at the mine*. It is then hoisted to the surface and transported directly to the japan manufacturer without going through any process of refinement.

Pitches, defined by Stillman as semi-solid or solid residues produced in the evaporation or distillation of bitumens. He says the term is usually confined to the harder residuums.

There are several kinds in use in japan and enamel formulae. These tend to make the japan elastic, heat-resisting and water-proof. There are three principal kinds used; stearin, candle, and cotton-seed. All come in soft, medium, and hard consistencies.

Drying Oils are used in paints, japans, and varnishes. Let it be understood that the drying in this case is not due to a process of losing moisture, thus decreasing in weight and volume, but to a process of adding weight and volume by oxidization. These oils in taking oxygen from the air become thick and then solid, losing their sticky or oily feeling.

I am especially indebted to Maximilian Toch for much of the following information on oils. This information was gained principally from his book, "The Chemistry and Technology of Paints," which is among the best in authority on the subject.

The term oil in this book covers the fixed and fatty oils containing carbon, hydrogen, and oxygen which decompose when heated to a high temperature. In general, pure oils are odorless and tasteless. Impure oils are not. Oils are lighter than water and insoluble in water. They are soluble in benzine, turpentine, chloroform, and carbon tetrachloride. They are partly soluble in alcohol. When hot they are *flammable*.

TABLE I

PHYSICAL AND CHEMICAL CHARACTERISTICS OF ASPHALTUMS

	GILSONITE SELECTS	JET ASPHALTUM
Specific gravity 78 degrees F., original substance dry	1.044	
Specific gravity 77 degrees F., original substance dry		1.076
Color of powder or streak	Brown	Brown
Luster	Lustrous	Very Brilliant
Structure	Homogenous	Pencillated
Fracture	Sub-conchoidal	Conchoidal parallel to grain, sub-conchoidal across grain
Moh's Scale		
Hardness	2	2
Melting Point	275 degrees F.	400 degrees F. approximately
Penetration at 78 degrees F	0	0
Dry substance:		
Loss, 212 degrees F., 1 hr. sample lump	.52%	.49%
Loss, 212 degrees F., 1 hr. sample ground	.64%	.61%
Loss, 325 degrees F., 7 hr. sample lump	1.335%	1.085%
Character of residue	Fused, surface granular	Softened, not fused
Loss, 400 degrees F., 7 hr. sample lump	1.44%	1.34%
Character of residue	Fused surface bubbly	Melted, surface rough
*Solubility in carbon bisulphide	99.98%	99.97%
*Solubility in carbon tetrachloride	99.96%	99.96%
*Solubility in benzol	99.81%	99.86%
Bitumen yields on ignition, fixed carbon	15.74%	18.89%
Susceptibility to attack by elements, acids or alkalies	Invulnerable	Invulnerable

---

* All solutions 24 hours at 70 degrees to 80 degrees F., 5 gram samples. Same results by extraction method.

The drying property of oil is measured by the chemist by its ability to absorb iodine. The iodine value for linseed oil is approximately 189 which means that one gram of the oil will absorb 189 centigrams of iodine. The higher the iodine number the better drying value and vice versa.

The saponification number is another characteristic by which oils are compared. It expresses the number of milligrams of potassium hydroxide necessary to saponify completely the gylcerides and fatty acids in one gram of oil.

> "This value is important, it showing freedom from adulteration with mineral oils, but does not assist in detecting adulteration with other vegetable oils since most of the naturally occurring vegetables have saponification values, which vary between narrow limits."
>
> (Toch).

Raw Linseed Oil is made from flaxseed grown in Canada, United States, Argentine, and India as well as around the Baltic Sea, and it is interesting to note that the oils from these various parts of the world differ much, due, probably, to climatic conditions and methods of harvesting.

In all of these countries, the manner of harvesting the flax is very similar. The modern harvesting machine is used, after which the flaxseed is separated from the flax stock by means of a modern threshing machine and is ready for the market. It is carried to various lake ports and comes down the lakes in large grain boats. Next it is conveyed from boats to grain elevators and separated according to the various grades and the source from which it comes. Then it is carried by means of large conveyors to the rolls. These consist of large corrugated rolls of steel between which the seeds pass until they are crushed into fine powder.

This powder is emptied into the tempering kettle on the floor below, where a certain amount of moisture and heat is applied by means of steam, the proper amount of moisture and the correct temperature being judged by the workman who is very expert at this particular trade. When the powdered flaxseed is in proper condition it passes out between two camel-hair mats. It is then placed in the presses, the mats being one above the other. When the press is entirely set up hydraulic pressure forces these mats together, pressing the oil out of the seed. The material left in the seed is the linseed-oil cake. All the surplus oil is found at the edge of the cake. The cake is passed through a trimming machine which takes off this edge. The cake is then baled up ready for shipping. It is used largely for cattle feed. The trimmings are sent back to go through the process again.

The oil is filtered in suitable presses by passing through cloths. It is then put into barrels. Linseed oil at this point is not in proper condition for use by the varnish maker on account of the fact that when heated to a temperature of about 450 degrees F. muscilagenous matter, otherwise known as the "break," separates from the oil. Consequently, it is necessary that the linseed-oil manufacturer further refine his oil, which he does by means of various chemicals and mechanical devices. At this point the various driers are added to the oils in order to make the boiled oils.

Boiled Linseed Oil, as will be seen from the table on the following page, is heavier and darker than the new grade.

The term *boiled* as applied to linseed oil is misleading, for linseed oil does not boil as water does, but when it is heated to a sufficiently high temperature it undergoes decomposition. However, it was long ago observed that if linseed oil is heated to a temperature somewhat below its decomposition point with oxides of lead and manganese some of the metals go into solution and the oil dries more rapidly than raw oil. This method of heating all of the oil with metallic oxides is practically obsolete.

In modern practice the manufacturer first makes a very concentrated boiled oil; that is one containing a comparatively large percentage of dissolved lead and manganese—15 to 20 times as much as is required in boiled oil. This material, known as crusher's drier, is mixed with raw linseed oil in the proportion of about 1 to 16 and the mixture heated to incorporate completely the crusher's drier with the oil. In some instances the crusher's drier is made from rosin and oxides of lead and manganese instead of linseed oil and the oxides. Boiled oil made this way is called resinate boiled oil, while that in which no rosin is used is called linoleate boiled oil. If properly made and no excessive amount of rosin is used a resinate boiled oil may be as good as a linoleate boiled oil, but the fact that much boiled oil contains an excessive amount of rosin and is consequently of inferior quality has caused resinate boiled oil to be looked upon with suspicion.

There is another type of boiled oil called bunghole oil, which is

TABLE 2
DRYING AND OTHER OILS
COMPILED FROM VARIOUS AUTHORITIES

NAME OF OIL	DRYING OIL	IODINE NUMBER	SAPONIFICATION NUMBER	COLOR	SPECIFIC GRAVITY AT 15° C	NATIVITY	ORIGIN	PRINCIPAL USE	REMARKS
*China Wood Oil									
Raw	......	Very little used	....	....	....	China, Japan	... .	....	Two grades Canton and Hankow
Treated	Yes	165	190	Yellow	.935	and Florida	Raw Oil	Moderate Price Varnishes	Has affinity for rosin and great hardness.
Corn	Slow	116	191	Golden Yellow	.925	U. S. A.	Seed	Soap making, color grinding. Used in cheap barn paints.	Will not sour or get rancid.
Cottonseed	Slow	106	190	Light	.920	South (United States)	Cottonseed	....	....
Heavy Mineral	No	12	6	Straw	.934	.. ..	.... ..	Baking Japans	An oxidizing oil.
Japanners' Prussian Brown	Yes	174	195	Dark	.968	Holland	....	Black Enamels	Cobalt Drier best
Linseed									
Blown	Slow	123	190	Pale	.968	Northwest States	Linseed	....	... .
Lithographic	Slow	102	199	Dark Brown	.978	Northwest States	Linseed	....	... .
Raw	Yes	189	193	Amber	.933	Northwest States	Flaxseed	.. . .	. ...
Lumbang	Yes	166	186	Yellow	.942	Tropics	Nut	Concrete, steel and flat-wall paints.	. ...
Menhaden Fish	Yes	178	189	Light	.925	Atlantic Coast	Fish	Linoleum, printing inks, hot-sun resisting varnish.	Pressed, bleached and blown.
Perilla	Yes	100	190	Amber	.920	....	....	....	....
Soya Bean	Semi	132	188	Golden	.923	Asia	Soy Bean	....	. ..
Stand, Marble, Enamel	Yes	171	195	Straw	.968	Holland	....	Air-dry and baking enamels	Cobalt Drier best
Sunflower	Semi	128	188	Pale	.930	Russia and Hungary.	Seed	Soap Making	....
Whale	Semi	140	187	Dark	.920	... .	.. ...	Blubber	Elastic and Soft

Note—Most of the above values were taken from Gardner and Toch. Note—Olive Oil and solid fats like stearin and palmatin are *non-drying*. *Also called Tung oil simply raw oil to which a drier, usually a turpentine or light mineral-oil solution of lead and manganese resinate or linoleate, has been added without heating.

Toch claims that not 5% of all the linseed oil produced is made into boiled linseed oil. To the person not versed in the composition of oil, it is simply a raw oil with drier added to it and compounded in the proper manner.

Blown Linseed Oil is a heavy bodied oil made by blowing air through linseed oil that has been heated to about 200 degrees F.

The value and function of many of the strange named oils (Table 2) is honestly recognized and it is not proper to term them substitutes for linseed oil for each has a recognized place in the manufacture of paint.

Soy Bean Oil (also called soya bean oil) is used in baking enamels in conjunction with other oils. It will not turn yellow under heat like other oils. This makes its application in white baking enamels apparent. The blown oil dries about twice as quick as the raw oil and gives a better flow and more gloss. While most soy bean oil has been of the pressed grade, that is, oil obtained under pressure, the paint manufacturer has become more familiar with the grade extracted with solvents, and this is preferred by many of the paint and varnish manufacturers who claim they are able to get better results with it than with the pressed oil.

Sunflower Oil has been of interest to manufacturers of high-grade enamels because of their desire to produce enamels such as have been manufactured in Holland for years and which are presumed to contain this oil. Manufacturers who have tried it in their laboratories have rarely been able to obtain satisfactory results and have found the oil extremely difficult to master.

Perilla Oil has aroused much interest. Its use has been found satisfactory, both as a paint and as a varnish oil. It has very good drying qualities, comparing quite favorably with the best grades of linseed oil. Its manipulation has been mastered quite well by those manufacturers who have gone into the oil carefully. Perilla oil has been commanding a price but slightly less than that of linseed oil. It would appear that perilla oil prevents, to some extent, polymerization and bodying of other oils and lengthens the time of cooking. Its presence noticeably increases the gloss of the varnish and causes it to dry to a heavier film. Its rather slow drying and high luster might make it useful as a finishing varnish for certain classes of automobile work. Varnishes in which the oil is used remain quite thin and do not congeal or gelatinize on cooling.

Tung Oil (also called Chinese wood oil, China wood oil) is an oil which surpasses linseed oil in its rapidity of drying. It has two important properties which are not found in linseed oil. A varnish made with tung oil will be very much more water-proof than that made with linseed oil. In the second place, tung oil has the property of causing the varnish to harden very much quicker than when linseed oil is used. These two properties make tung oil a very important and essential feature in certain classes of varnish. By the use of linseed oil and tung oil results are accomplished which were unknown years ago. The important feature, which must be remembered, however, is that while tung oil is an excellent oil for certain purposes and has its special advantages, at the same time, linseed oil has certain properties which make it in some cases very much better. Tung oil has come to stay with varnish makers, for without it they would be at a loss to know how to accomplish certain results. It is interesting to note that the cultivation of the tung tree is one of Florida's new industries and that the quality of the product is far superior to that which is imported.

It is said by some authorities that the gelatinization of tung oil by heat is accomplished by a large absorption of oxygen; by others, that this is not so—but is due to a chemical change. The latter seems more nearly correct.

Tung oil derives its name of wood oil from the fact that it is used as a protective coating for wood in China. There it is used as a sort of varnish. It is easily combined with lead and manganese oxides to form driers, and a certain proportion of lead in combination is said to make a film glossy and transparent instead of flat and opaque. Since the method of treating it has become better known tung oil has been used more. It is of little use in its natural condition, but when it is converted into a stand oil it acts entirely different.

Japanners' Brown Oil (also called japanners' Prussian brown, leather blue oil, and japanners' black) is the same as *stand oil,* except that it is very dark in color—so dark, in fact, that its principal application is in making blacks requiring a high gloss.

I am glad to quote the following description of the process of manufacture of japanners' brown oil as explained by Maximilian Toch in a personal letter:

> Japanners' brown oil is an excellent, flexible, tough drying oil, adaptable to a number of uses and is produced by compounding a suitable linseed oil with japanners' brown.
>
> The usual proportions are from 1 to 4 ounces of dry japanners' brown to 1 gallon of oil. A good grade of linseed oil, refined for varnish makers' use, should be used.
>
> The japanners' brown may be added either in the standard dry pulverized form, or as a paste in varnish linseed oil. The latter is used by those who find that, because of local conditions, objectionable dusting cannot be overcome.
>
> The average paste contains 43% of oil, the volume of which should be subtracted from the quantity first put into the kettle.
>
> One hundred gallons of oil are put into an open kettle, heated to between 300 degrees to 325 degrees F., and the japanners' brown added. Stirring should be constant. If dry material is used, care should be exercised to prevent excessive dusting.
>
> Gradually increase heat till temperature reaches 580 degrees F., then draw kettle from fire. The rise from 300 degrees to 580 degrees F., should require an hour and a half, or a little longer.
>
> Stirring should be intermittent, and sufficient to keep solids in suspension.
>
> Quite a head of foam will form, and, when necessary, if rise is too rapid, should be broken with a whip, or kettle temporarily removed from fire. This action will vary with different types and lots of oil.
>
> Test for solution of solids, by dropping some of the oil on glass and holding up to light.
>
> Allow temperature of batch to drop to 500 degrees F., and then run another heat to 580 degrees F.
>
> Solution of the japanners' brown will be complete, and oil should now be tried on glass for body. The usual consistency desired is similar to that of molasses.
>
> If thinners are to be added, a volume equal to that of the oil may be incorporated, when temperature has dropped sufficiently.
>
> If heavier body is demanded, another heat to 580 degrees F. must be run.
>
> Leather blue, preferable in oil, may be used instead of japanners' brown if it is desired to reduce the foaming.

Raw China Wood Oil (also called raw tung oil) is always cooked before it is used, generally with either rosin or with linseed oil added to prevent jellying. It is then ready to be used as an oil, or in making varnishes. It has a strong and peculiar odor resembling rancid grease. It is of a yellow color, much darker than linseed oil. When it is dried on glass it dries "flat" with a rough surface, not glossy, and makes an opaque white film. If it is heated to 400 degrees F. it coagulates. Apparently the whole mass of the oil undergoes a chemical change and is converted into a jelly. It does not "break" like linseed oil. It is insoluble in all the ordinary solvents. Great care must be taken in heating it on account of this.

When placed in a bottle and exposed to the light, even though the bottle be air tight, this oil will, by the actinic rays of the sun, be converted into a lard-like mass. This property is very easily overcome by the heating of the oil. The gelatinizing of the oil also is very easily taken care of by proper treatment with various gums, and so forth. However, the most difficult feature to overcome is that of *drying flat*. This is due to a wrinkling of the varnish film. Manufacturers have now thoroughly mastered this.

STAND OIL (also called marble oil, enamel oil, and japan oil) has the properties of heavy bodied linseed oil. It is used extensively in the making of air-dry and baking enamels. Toch is authority for the statement that this type of oil is made by heating up to 550 degrees F. a grade of linseed that is free from black flocculent particles, or, in other words, a linseed oil that does not *break*, and keeping it at that point until it becomes viscous. He says also that when the specific gravity increases to 98 degrees F. a small quantity is placed upon a piece of glass for test. It is about right if it *stands* in little hills and runs very slow. Brush marks are sure to flow out and disappear in enamels made with this type of oil. Zinc oxide is used as the basic pigment.

RESINS (also called gums) were originally found on the surface of the ground by criminals and floaters in New Zealand (Table 3). They used an exploring rod or prodding stick. Today the diggers go beneath the surface (often 20 feet), like miners, sometimes getting a ball two or three feet in diameter. The trade nomenclature of the various resins used in the varnish industry is not definite in all cases, but the following classification will suffice.

COPALS, which include the hard fossil resins, are formed by age and exposure to air, from the exudation of certain trees found in

New Zealand and various parts of the Tropics. The term fossil resin is supposed to designate a very old product which is dug from the earth, but some varieties of resins are found in all conditions, from the fresh to that which has laid deeply embedded for a long period of time.

The definite classification of all gums or resins into such groups as fossil, semi-fossil, and recent, involves uncertainty. For varnish purposes the older the resin the more valuable it is. Zanzibar is considered the hardest and most valuable of the copals, while Kauri is the most used at the present time. The copals appear on the market in various grades, the classification being based on color, freedom from foreign matter, and so forth. The different grades are classified according to size, as *bold, nubs, seeds,* and *dust.* The supply is limited and in time manufacturers will be forced to find substitutes. Many manufacturers at present will not use those resins, the supply of which cannot be assured. Benguela, for example, has already practically disappeared from the market.

TABLE 3

RESIN TABLE

DEGREE OF HARDNESS	SOURCE	FOUND IN	NAME	COLOR
Hard fossil	Exclusion of trees 1,000 years old	Africa (East coast)	Zanzibar (True) Madagascar Benguela Bastard Angola Red Angola	
Semi-fossil	Exclusion of trees 500 years old	East India East India Africa (WC) New Zealand	Pontianac Manilla Congo Sierra Leone Kauri	White White Very Light Light and dark
Soft or recent These are *not* called copals	Insects Pine trees Trees	Java	Shellac Rosin (Colophony) Damar Borneo Singapore	White

Damar is formed from the exudation of certain trees. Damar is generally classified according to the place from which it is shipped to the market, as Singapore Damar, Batavia Damar, and so forth. It is used chiefly for the preparation of spirit varnishes. It is found in lumps, drop-shaped or flat pieces, grains or tears, as well as in larger masses, indicating that it exudes from the tree as a liquid resin and afterwards hardens.

There is a dark brown variety called *black damar*. The heat of the hand is sufficient to make it sticky and when heated further it begins to melt at 75 degrees F. At 150 degrees F. it is a thin, clear fluid. There are, however, varieties of damar which melt between 180 degrees and 200 degrees F. Damar is entirely soluble in benzol and spirits of turpentine.

Rosin (also called colophony) is the residue left in the still after the distillation of turpentine.[1] It is graded according to color, the lighter colored varieties being the most valuable. When used as a varnish material, rosin is generally, but not always, hardened by the addition of lime. Treatment with zinc or calcium oxides not only hardens rosin but also lessens its acidity. The addition of too much oxide makes the product too hard and insoluble. The hardness of rosin is also greatly increased. The acidity is decreased by prolonged heating. Rosin has generally been considered as an improper material to use for high-grade varnish since, when present in considerable amounts, it causes varnish films to be brittle, to turn white with water, and generally lowers the wearing qualities.

However, fine varnishes are now made which contain small amounts of rosins. Tung oil-rosin varnishes, which contain considerable rosin, are considered as high-grade products for interior use.

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[1] See Figure 10, page 41.

IV

JAPANS AND ENAMELS

Carbon Black
Drop Black
Charcoal Black
Ivory Black
Lampblack
Graphite
Mineral Black
Rubber Japan
Dull Black Japan
The Real Bauer-Barff Finish
Semi-gloss Japan
Black Baking Japan
Black Enamel
Crystal Japan
Crinkle Japan
Crinkle and Sag Japan
Colored Specialty Finishes
Black Patent Leather Enamel
Leather Japan
Pure White Lead
Sublimed White Lead
French Zinc
Barytes
Earth White Pigments
Fuller's Earth
Lithopone
Calcium Carbonate
Marble Dust
Precipitated Chalk
Titanox
Colored Enamels

Carbon Black (also called gas black, silicate of carbon, ebony black, natural-gas black, jet black, hydrocarbon black and satin gloss black) is made by the incomplete combustion of natural gas. It is deposited by actual contact of a flame on a metal surface. It has an intense color, far blacker than lampblack. It does not work well for tinting purposes.

Drop Black (also called blue black, ivory black, bone black, coach black, and Frankfort black) is made from burned animal bones. It has a very stable color. It is made in a retort from which the air is excluded. The resulting bone charcoal contains 10% to 20% of carbon. To this it owes its fine black color. The rest is largely calcium phosphate.

Bone black may contain Prussian blue which is added to modify its color (see also charcoal black).

Charcoal Black (also called Frankfort black, vine black, and blue black) being of vegetable origin is made from burned grape

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N. B.—In this chapter an attempt has been made to clarify the names of pigments from a practical standpoint. The duplicate names following the title are not really synonymous with the principal ones at the head of the paragraph, otherwise there would not have developed two names to cover exactly the same thing. There are slight differences to prove the identity of most of the secondary names mentioned.

vines, trees, twigs, and so forth. It is used principally in water color (see also drop black).

Ivory Black was formerly made by heating waste pieces of ivory in a closed crucible. On account of the scarcity of raw material, it is almost wholly replaced by drop black.

Lampblack is made by the incomplete combustion of oils and fats. It is soot and contains fatty matter in the first stage, which must be burned out in order to make it suitable for use in paints. It is used a great deal in tinting. It has an intense grayish black color.

Graphite (also called plumbago and black lead) is a form of carbon found as a natural mineral. Its dull grayish color makes it undesirable for most exposed surfaces.

Mineral Black (also called keystone filler) is ground coal or ground shale.

Rubber Japan gets its name from its similarity in appearance to hard rubber. It is used as a first coater because of its binding and covering quality. Literally, it seems to *flow* into the pores when the metal to which it is applied is expanded by heat. A typical formula for this material is as follows:

⅝ gallon black japan
⅛ gallon turpentine
¼ gallon Kauri varnish
½ pound carbon black

By varying these ingredients different shades and grades may be obtained. There are innumerable other formulae for rubber japan. Fundamentally, however, it is black baking japan with enough black pigment added to deaden the gloss of the black baking japan. Sufficient turpentine is added to reduce the mass to a working consistency. The Kauri long oil grinding varnish is included to facilitate the difficult grinding of the carbon or bone black. The carbon pigment often settles when standing which means that it must be stirred before using.

Sometimes, streaks or strips are noticed in rubber coated parts after they have been dipped. This effect is due either to poor mixing or grinding at the factory or not being thoroughly stirred before using. It is the pigment that furnishes the covering and opaque quality to rubber japan.

Dull Black Japan is a form of rubber japan that is devoid of gloss. The dullness is due to the amount of pigment ground into the vehicle or liquid by the manufacturer and secondarily, to the degree of heat applied in the baking. Dull black japan is used on most telephone stands the world over. Perhaps no coating material was ever studied more thoroughly than this. Certainly, none cost so much in time and money spent in development. To the author's personal knowledge, at least an average of 10 persons have been working constantly toward the improvement of this one material for a period of 16 years. I had the pleasure of working on this in 1906 and 1907 when the Western Electric Company first decided to use black japan on brass desk stands that had previously been nickel-plated. The first dull black japan that was used failed because it was attacked by the acids coming from the hands of certain users. Too, the coating failed to stick to the brass and this had to be overcome. At one time, a mild sand-blasting of the surface was introduced. Incidentally, this particular grade of japan is often applied as an imitation Bauer-Barff finish.

The Real Bauer-Barff Finish which is said to be rust-proof is much used on building hardware. It is named after the originator and is applied as follows:

> The iron or steel articles should be clean and given a light sand-blasting. They are then placed in a closed retort or furnace where they can be heated to cherry red—about 1,250 degrees F. When the articles have reached this temperature, super-heated steam is injected into the retort, which develops a black magnetic oxide of iron upon the iron or steel. It takes several hours to produce a good coating. When cool the surface is wiped with a thin coat of linseed oil and then heated at 212 degrees F. until the oil becomes dry. This changes the magnetic oxide to a slate gray or the regular Bauer-Barff finish.

Semi-gloss Japan is a mixture of rubber japan and gloss black baking japan. It may be reduced 20% and bakes in from 15 minutes to 3 hours, depending upon the manufacturer's formulae. The number of shades of this material between dull and gloss, obviously are without limit.

Black Baking Japan (also called Brunswick japan) is the most popular and most used material in the art of japanning, for it is applied on filler, over rubber, over itself, but more often alone. It has a glossy appearance, is hard and smooth when it comes out of the oven, is very elastic, is a non-conductor of electricity, is acid-proof and water-proof. Also, it is alkali-proof to a considerable degree. This material is usually shipped in five-gallon varnish cans, in drums or in wooden barrels. It does not settle or separate and does not have to be stirred, except just after being reduced with benzine.

It has the fine property of thoroughly amalgamating with a certain amount of benzine, so that it does not have to be stirred again. It can be reduced from 25% to 100% and bakes at varying temperatures and lengths of time. It is inclined to be transparent on sharp edges of metal parts. The transparency can be corrected only by the addition of some rubber japan to it or by the use of an undercoat of rubber japan. A typical formulae for gloss baking japan is as follows:

100 pounds gilsonite (asphaltum)
60 pounds pitch
10 gallons linseed oil
40 gallons turpentine
Melt the gilsonite, stir in the linseed oil, cool and then reduce to the proper gravity with turpentine.

A common trouble in japan application is called pitting. Many causes for it have been suggested, but Maximilian Toch in a personal letter to me seems to have covered the matter when he suggests that the trouble occurs more in winter than in summer and that it is now regarded as being due to the crystallization of the fatty acids in the oils and that the remedy is in filtering out the fatty acids which crystallize when linseed, soya bean or tung oils are pressed at temperatures of say, 16 degrees above zero.

BLACK ENAMEL differs radically from black japan because it is really a varnish. The formulae for the two are in no way similar, as will be noted from the following typical one for black enamel:

PART 1—10 pounds amber or copal resin
5 pounds boiled linseed oil
PART 2—10 pounds gilsonite (asphaltum)
5 pounds boiled linseed oil
Heat parts separately, then mix together and thin to the right gravity with turpentine.

Crystal Japan (also popularly, but erroneously, called crystallizing lacquer) is, as the name indicates, a finish which has an alligatoring effect (Figure 6) which is really beautiful. It is a special application on cameras, precision instruments, radio apparatus and the like. It should be bought fresh and already mixed from a reliable manufacturer. There is a certain manipulation of the oven which is necessary to produce this finish which has a mixture of dull and shiny crystals. The oven must be brought to a temperature of 100 degrees F. and kept there for about three-fourths of an hour. During this time the air intake vents should be closed and the oven should be kept dark. Once the crystals are formed the vents may be opened and the temperature raised to 350 degrees F. for half an hour. (It could be baked at 250 degrees F. for two hours.) The heavier the coating the larger the crystals will be and vice versa. The material is best handled in an open flame gas-oven where the air is foul. Untreated tung oil is the basis of this finish.[1]

Figure 6—A Sample of Crystal Japan

This effect can also be produced in colors by using clear material as above, without pigment, on whatever color of background one desires, care being taken not to bake high enough to harm the background material. Beautiful color effects can be gotten by intermixing colored crystallizing lacquers or in shading crystallizing colors by adding black crystallizing lacquer.

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[1] See page 24.

Figure 7—A SAMPLE OF CRINKLE JAPAN

CRINKLE JAPAN is new. It is a special application of a material similar to crystal japan and produces, as the name indicates, a peculiar crinkle effect. This (Figure 7) is secured by placing the freshly coated parts in a very hot oven.

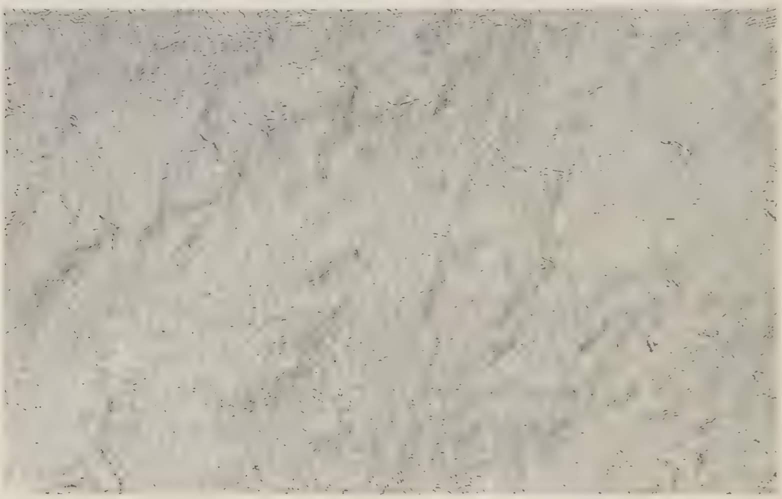

Figure 8—A SAMPLE OF CRINKLE AND SAG JAPAN

The oven used should be of the indirect type which means that pure air and not foul air is essential—thereby differing radically from crystal japan. However, a direct oven will produce the crinkle effect.

Crinkle and Sag Japan (Figure 8) is a very new sprayed specialty that is popular on radio sets. The peculiar effect is secured by flooding or applying horizontally excess crinkle material as described; and allowing it to sag after holding it in a vertical position. This can be done easily and uniformly with a little practice. This finish will be quite popular on radio equipment produced in 1928-9.

Colored Specialty Finishes are secured by spraying a coat of non-filling lacquer, such as bronzing liquid, over an undercoat of either crinkle or crinkle and sag japan.

These various special finishes are known and described by many in many ways and by many names and about the only way that one may be sure not to become confused is to refer to the illustrations herein.

[Note—There are some non-baking specialty lacquer finishes described in Chapter II, page 14, that should be considered in connection with these finishes.]

Black Patent Leather Enamel is very well explained by Dr. A. H. Sabin of the National Lead Company in a paper read before the Pennsylvania Master Painters as follows:

> We all know that boiled linseed oil has more gloss than raw oil; and some of the old-fashioned kettle-boiled and what was called double-boiled oil was quite suggestive of a varnish; not a high gloss to be sure and not very lasting, but noticeable. Some one observed that there is not a finer surface than that on good patent leather, and it stands exposure and ill-treatment; and it is nothing in the world but linseed oil. To make it the oil is cooked for a long time at a high temperature, until finally it turns into a jelly.
>
> The hot kettle of this over-cooked oil, which contains a considerable amount of a perfectly black drier made with an iron compound, which is perhaps the most powerful drier there is and which colors the oil black, is drawn out away from the fire; all the fire extinguished by sluicing it with water; then the benzine, pailful after pailful, is stirred into the over-heated oil. Most of it evaporates almost immediately at first, but the attraction between it and the oil is very great, and as the

> oil cools more of it stays in the oil until at last the mixture is cool and like a brownish-black custard. This is varnish. For the first coats on the leather an enamel paint is made by mixing some lampblack with some of this thin jelly, which is applied with a sort of a spatula. As these coats dry they are rubbed down, and a final coat or two of oil is applied. This gives the wonderful gloss.

Leather Japan (Figure 9) is an entirely new metal finish—a creation of the Finishing Research Laboratories, Inc. It is the first real, durable variation of the smooth gloss and dull black japan finishes that has been produced. It is just as durable as black japan and is capable of being produced in large or small grain effects depending on the particular effect desired. Variations of it can also be applied on wood, but obviously the material must be especially designed in order to produce the effect at a low temperature.

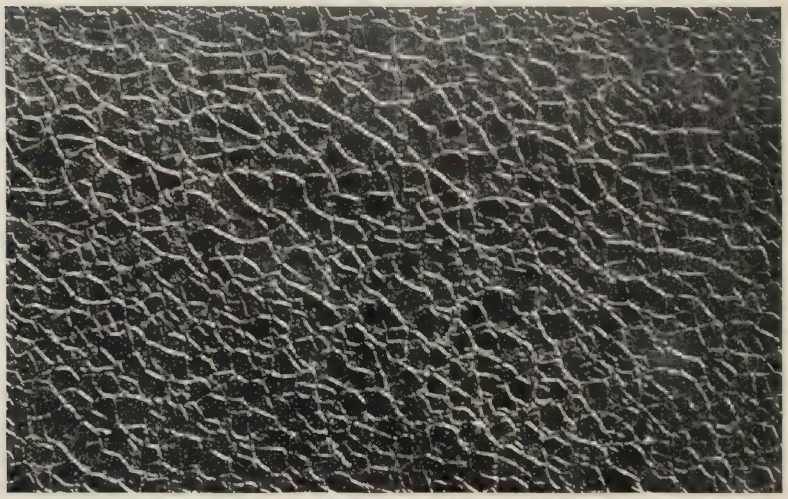

Figure 9—A Sample of Leather Japan

Pure White Lead (also called flake white) is a basic hydrated lead carbonate in the proportion of about 25% of the hydrate to 75% of the carbonate. It is made by adding weak acetic acid to metallic sheets of lead to corrode them. These are then covered with manure and tan bark. The heat from the manure sets the acid vapor free and turns this lead into lead carbonate. Next it is thoroughly washed to remove dirt and acid, after which it is settled and dried. Finally, it is either mixed with oil or marketed in the dry state. It is heavy and opaque. Flake white is a high-grade pure white lead.

SUBLIMED WHITE LEAD (also called sulphate of lead, sublimed lead, basic sulphate, sulphate of lead, white lead) is a lead sulphate containing about 5% of zinc. It is especially useful in dipping materials, because of its better body and fine texture.

FRENCH ZINC (also called zinc white) is made from metallic zinc. (American zinc is made from ore instead of metal.) The spelter is placed in retorts and vaporized. As the vapor rises it meets a blast of fresh air which changes the vapor to zinc oxide. It is not as opaque as white lead. Its atoms have a great affinity for each other, which makes the material most lasting than white lead.

BARYTES (also called barium sulphate, permanent white) is used principally as an extender of strong colors. It is not a poison on account of its great insolubility, contrary to the claim of some, as was demonstrated before the Committee on Public Welfare, State of Wisconsin (1921), by swallowing four tablespoonsful in a glass of milk.

TABLE 4

EARTH WHITE PIGMENTS*

CLASS	BASE	COMMON NAME	BODY IN OIL
Aluminous	Clay	China Clay	Good
		Kaolin	Good
Cretaceous	Chalk	Whiting (lime carbonate)	None
		Gypsum (lime sulphate)	None
Silicious	Silica	Wood Filler	None

*For detailed information on Colored Pigments, see Volume I, *Practical Color Simplified,* Chapter X.

EARTH WHITE PIGMENTS are divided into three general classes as will be seen by referring to Table 4.

FULLER'S EARTH is a mineral product like clay. It has a great absorbent power for coloring matter and is used to clarify and decolorize paints in the process of manufacture.

LITHOPONE is usually made by adding barium sulphide to zinc sulphate. The resulting precipitate of barium sulphate and zinc sulphide is filtered off, calcined at low red heat and plunged into cold water. This treatment gives density or body to the product. Next it is ground, dried, and powdered. The best grades contain nearly 30% zinc sulphide, 5% zinc oxide and 65% barium sulphate. Lower grades differ chiefly in having ground barytes added. Well-made lithopone is white in color, fine in texture, and almost or altogether equal to white lead in body and opacity.

Lithopones vary widely in their behavior on exposure to bright light. Some darken while others retain their color. This darkening is apparently caused by a chemical change in the zinc sulphide. Paints made of it rapidly decay on exposure outdoors, but it is much used for inside work, especially in flat wall paints and enamels for furniture. Owing to the unstable condition of the zinc sulphide, it would seem that it should not be used with basic carbonate white lead. However, the two pigments are sometimes successfully used together.

CALCIUM CARBONATE (also called natural chalk) is ground, levigated and graded according to fineness and whiteness into *Paris white, gilders' whiting* and *commercial whiting.* The first two are bulky and very fine and are used in paints to aid in suspension of the pigment and to neutralize acidity. Commercial whiting is used chiefly in calcimine and putty.

MARBLE DUST is crystaline in character and gives *tooth* to paints. It settles out very rapidly which makes its use rather undesirable. Ground limestone has characteristics similar to marble dust.

PRECIPITATED CHALK (also called alba whiting) is very pure and extremely bulky. It may be used instead of Paris white or gilders' whiting.

TITANOX is a composite pigment that has been in use since 1914. It is noted for its hiding power. In fact, Dr. Henry A. Gardner places it above that of lithopone. It is a white, very fine uniform powder, chemically stable and inert. It is light proof and stands high baking temperatures without discoloration. It is a mixture of 25% titanium oxide and 75% barium sulphate. This pigment plays an important part in baking enamels.

Colored Enamels are divided into two general classes; air-drying and baking. It is possible to *bake* an air-drying enamel, but this will tend to make it brittle. It is possible to *air-dry* a baking enamel, but it will take a long time. Such an enamel will be likely to dry on the surface and remain soft underneath.

Then too, such troubles as wrinkling and blistering may develop later. It is advisable to use material that dries reasonably slow, as greater durability and sometimes better color, luster, and smoothness can be secured. In the case of rubbing enamel it is possible to secure one which will rub in 24 hours, 36 hours, or 48 hours. Everything else being equal the 48-hour rubbing enamel is the best.

However, it must be understood that there are exceptions to this rule. In a baking enamel in light tints or in white the ordinary baking temperature on wood is from 110 degrees F. to 130 degrees F. and on metal is from 150 degrees F. to 280 degrees F. In dark shades, materials are furnished to bake as high as 450 degrees F.[1]

I recall, some time ago, a specification written by an architect, which directed the use of nine coats of white enamel, each coat baked at a high temperature. The architect evidently wanted a high-class finish that would last a long time; but, if his specification was followed, it is doubtful if there would be any union between the metal and the finish as a whole by the time the last coat were applied, because the first coat would have been baked nine times and would have all the life and adhering properties taken out of it. It is a rare case where more than three coats of baking colored enamels or whites are applied to a single surface.

White, though not scientifically rated as a color, is really the basis of most colored japan enamels. In order to fit into common practice the term *japan enamel* should be shortened to *enamel.* Strange as it may seem, color is important even in the selection of a *white enamel,* for absolute white does not exist. It is either slightly bluish, slightly yellow or slightly pink in color. White enamel may be purchased having any one of these tones. The white that is slightly bluish, is usually considered the "whitest" by the ordinary person.

Some enamels are used for outdoor work; others are used for indoor work. Some are used for coating articles of furniture which may receive hard usage. Others are applied to surfaces that will seldom, if ever, become marred. For each use there is a special colored baking enamel formula.

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[1] See Volume I, *Practical Color Simplified,* Table 5, page 32.

V

REDUCERS

Reducers
Wood Turpentine
Gum Turpentine
French Turpentine
Russian Turpentine
Venice Turpentine
Naphtha
Benzine
Kerosene
Oleum Spirits
Mineral Spirits
Benzol
Turpentine Substitutes
Synthetic Turpentine
Solvent Naphthas

Reducers (also called thinners) are used to condition the paint or japan and bring it to the correct viscosity for working. They vary widely in price and, as a result, there is a tendency to use the cheaper reducers such as benzine in preference to the higher priced ones such as turpentine.

A few simple laboratory tests using the various kinds of thinners will determine which is the most economical and remove all doubt as to the injurious action on the finishing material that is being used.

Wood Turpentine is made by distilling with steam, pine stumps and broken down trees. It represents about 10% of the production of turpentine in the United States. It is of a poor grade and has a very offensive odor, although an attempt is made to disguise this odor with oil of pine, which has no real function, except to conceal the smell and make the user believe he is getting real gum turpentine.

Gum Turpentine (also called turpentine, oil of turpentine, pure turpentine, spirits of turpentine, and turps) is a light volatile oil obtained from various kinds of pine trees, particularly the long-leaf yellow pine. Seventy-five per cent of the world's supply comes from the United States. About half of this comes from the States of Florida and Georgia. At one time North Carolina produced the bulk of the world's supply.

Gum turpentine is obtained by tapping the living pine tree. This gum is collected in one or two quart capacity galvanized iron, or baked clay, cups about once a week. The following information furnished by the U. S. Department of Agriculture will be interesting to the japanners:

> To overcome unnecessary evaporation loss, turpentine producers equip their stills with automatic separators and receiving barrels.
>
> Figure 10 shows the construction of a home-made automatic separator. A 6-inch funnel (A) is set in place in a hole in the cover of the separator barrel, which is provided with a turpentine offtake pipe (B) and a water overflow pipe (C) placed on a level with B. B fits snugly into the cover of the turpentine settling or receiving barrel (D). This cover is in two halves, and is easily removable to permit the dipping out of the contents. For drawing off the water a faucet (E) is placed as close to the bottom of the tank (D) as possible, while another (G) in the separator barrel may be assembled from one-inch nipples and valve. To prevent the water globules from flowing through the offtake pipe (B) into the tank (D), a piece of thin cotton cloth (F) is stretched tight and tacked in place in front of the opening.

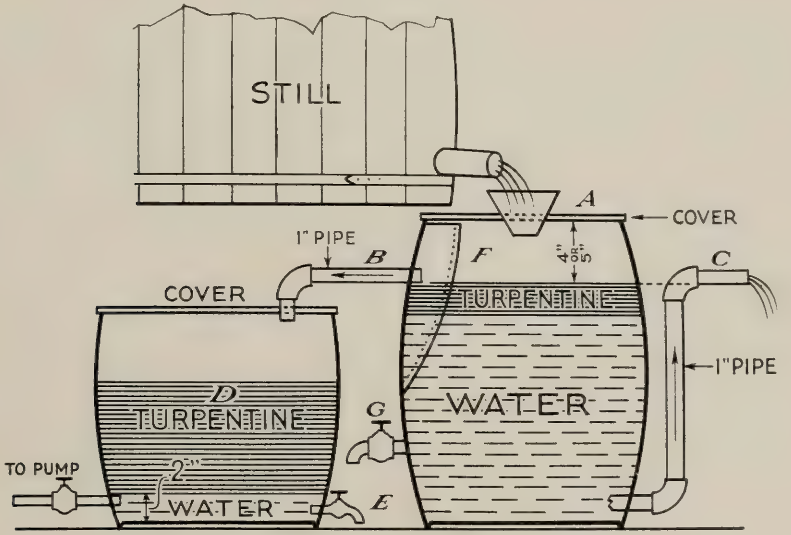

Figure 10—A Turpentine Separation Plant

The principal use of turpentine is for thinning paints and varnishes, approximately 85% of this country's consumption being employed for that purpose. About 45% is used by the manufacturers of these products, and the other 40% by painters in mixing and thinning paints and varnishes at the time of application.

Turpentine will readily penetrate through the staves of an ordinary wooden barrel. It is, therefore, necessary to coat the inner surface of the barrel with ordinary glue, which is insoluble in turpentine but readily soluble in water. As turpentine will leak out of a barrel not properly glued, great care must be taken in applying it to the barrel, and finally also in so filling the barrel with the turpentine that no water gets into it.

French Turpentine (also called Bordeaux turpentine) is a more expensive kind, made in southwestern France. Its drying qualities are said to be better than the American grade.

Russian Turpentine is obtained from the Scotch pine. Its drying qualities are poorer than either the American or the French grade.

Venice Turpentine is an oleo resin from the larch tree found principally in Europe. It does not fluoresce or turn white. Its cost is several times higher than that of crude turpentine.

Naphtha (also called V. M. P. Naptha—meaning Varnish Makers' and Painters' Naphtha) is a particular grade of benzine that is free from moisture, the presence of which in baking japans will cause little pits over the surface of the metal where miniature explosions occur, when the moisture is changed into steam.

Benzine is below 95 degrees F. flash. Its boiling point is 120 degrees to 150 degrees F. It may have either a paraffin or an asphalt base. The specific gravity is 65 degrees Baumé. Many paint and varnish makers have found that they can use benzine, which is cheaper than so-called turpentine substitute, and, therefore, they have arrived at the conclusion that benzine will meet their wants by further addition of a small quantity of kerosene to slow down the evaporation of benzine. There always seems to be a demand for inferior goods where low price is the main object.

Kerosene (also called coal oil, water white oil) is the step in the process of distilling crude oil, following the gasoline and preceding the lubricating oils and paraffin. Its use in japan is not great but some companies do use it instead of benzine. However, it reduces the gloss. Also, it takes longer to evaporate It leaves a greasy spot on white paper and its odor is, of course, characteristic.

Oleum Spirits is a naphtha much used by japanners because it is slightly cheaper than V. M. P. Naphtha and evaporates without leaving any residue. It is slower in evaporating; in fact, the slowest really volatile thinner there is. The underwriters classify it the same as kerosene. It is better than kerosene since it is not oily.

Mineral Spirits (also called turpentine substitutes, heavy naphtha) is a hydrocarbon that comes over from the still of crude oil in turn after the gasoline and benzine and before the kerosene. When the water-white oil is high the oil refiner can find a market for the combination of the two, heavy naphtha and kerosene, without having to separate them. This, of course, lowers the grade of the turpentine substitute. Properly and correctly prepared paraffin or asphaltum base turpentine substitute which will meet the various government specifications for turpentine substitute or mineral spirits, very seldom cause any serious trouble when used, but their solvent properties and therefore their range of usefulness is not as great as pure turpentine.

Various heavy distillates of either paraffin or asphaltum base origin have a great density or specific gravity. Sometimes they contain more or less non-volatile greases. The use of such a material should be discouraged whenever possible, since paint or varnish products containing a thinner of this nature dry unsatisfactorily and the use of it may lead to other troubles.

To determine the actual value of mineral spirits, place a few drops on a clean white paper alongside of a sheet containing a few drops of pure turpentine. That on the paper containing the pure turpentine will evaporate in about 20 minutes and leave no stain or grease. However, if the sample of mineral spirits contains non-drying greasy material it will be readily noticed on the white paper when held up to the light. Some turpentines will dry so as to leave a residue that is almost invisible unless held up to the light. What the japanner wants is a substitute with the necessary fire test, a slow evaporation, and one free from grease.

A mineral distillate, made to take the place of pure turpentine, will spread easily, cut properly, and dry practically as quickly as turpentine. There may be a small amount of wax if kerosene is used in the place of mineral spirits, particularly if it be made from paraffin base oil. The best substitutes are made from the asphalt base oil which contain no paraffin. Should there be any wax or grease in the distillate used in an undercoat it would cause the coat to remain soft underneath. It would also cause slow-drying and, if the finishing coat is of a hard-drying, quick-setting nature, it would alligator.

BENZOL (also called coal-tar naphtha and benzene—not benzine) (Table 5) is valuable in paints that are used on new yellow pine, because of the penetration into the wood and softening the rosin in it. It is often erroneously confused with petroleum ether or petroleum spirits. Benzol is a good solvent of tar and pitch. Its specific gravity varies from .875 to .885. It is used extensively in varnish removers.

TABLE 5

BENZOL DATA

KIND	CHARACTERISTICS	SPECIAL USE
Pure Benzol	Quick Evaporation	Very Strong Solvent
100% Benzol	Volatilizes at 100 degrees C.	General Solvent
90% Benzol	Fair Evaporation	Common Solvent
50% Benzol	Slow Evaporation	

Benzol is used in enamels because it does not leave behind, after evaporation, any oily residue. It has an offensive coal-tar odor.

TURPENTINE SUBSTITUTES are rated by the Underwriters' Laboratories as follows:

> These materials appear to be essentially refined petroleum distillates. Their hazardous properties are somewhat greater than or in a class with those of turpentine, as determined by Underwriters' Laboratories *rating schedule* which is as follows:

Ether	100
Gasoline	9—100
Turpentine	40— 50
Kerosene	30— 40
Paraffin Oil	10— 20

SYNTHETIC TURPENTINE is a mixture of heavy petroleum naphtha and either wood or pure gum turpentine. It is made to smell like the pure grade by the addition of oil of pine and oil of citronella, neither of which have anything to do with the quality of the material. Much depends upon the proportion of pure turpentine to naphtha for the mixture soon reaches a point where the material to be thinned will curdle. Certainly there is no legitimate use for a mixture of this kind aside from reducing the price.

Solvent Naphthas are mineral products. They are water white and have a sweet odor. They are very similar to benzol, except for the higher boiling points and slower evaporation. They dissolve the more difficult soluble blacks used in high-grade baking japans. They prevent *flooding* and help in getting the desired *flow*. The specific gravity varies from .862 to .875.

VI

PUTTIES AND FILLERS

PUTTY	FILLER
PUTTYING	FILLING

PUTTY is used in filling holes in castings. The formula for putty which I have used for a number of years is as follows:

24 pounds bolted whiting for body
1 gallon mixing varnish for vehicle
1 pound lampblack for color
Reduce as desired with benzine.

It is really a very thick baking iron filler.

PUTTYING being the first operation in building up a finish should demand close attention. It is the first material that is applied to castings and other metals where it is necessary to fill up sand holes or obliterate deep scratches. Taking the plane of the surface to be worked on as zero, putty should be used to patch up holes and indentations below this plane. It should *not* be used at all above this zero plane and whenever used should be applied in a number of thin coats, never in chunks.

When it is realized that this material is subjected to at least one, and, possibly, several bakings up to 400 degrees F., it will be seen that any moist or non-dried part of the putty will cause a change in its shape. If the putty shrinks it will cause a depression, while if it expands, as it is bound to do if not properly mixed or applied, a raise above the zero plane will result. Precautions about mixing the putty as well as extreme care and avoidance of haste in applying it too thickly, before the undercoat is allowed to dry, will go a long way toward reaching the ideal, which is the zero plane referred to above.

FILLER is really baking iron surfacer or rough stuff as it is called in the automotive industry. After all the holes and indentations have

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See *Practical Automotive Lacquering*, Volume II, Chapter V, for detailed information on putty knives.

been filled with putty, the next step in building up a high-class japan finish is the application of the filler coat. This is an iron-like material which has the property of hardness, yet can be sanded smoothly. By its use, the *zero plane* is raised by the thickness of the filler coat after it has been sanded. Most fillers of this kind become hard before they can be sanded out. We have tried out made-up fillers which have air-dried so hard that they could not be sanded. This was due to the mineral pigment used. After making our own filler by hand for a number of years, using the formula:

10 pounds bolted whiting
1 gallon mixing varnish
½ pound lampblack
Thin with turpentine.

we found a manufacturer who supplied us. His product was superior because it was mixed by machinery.

Filling may be done by brushing, but it can be more evenly and cheaply applied with a spray-gun. We have been advised again and again that due to the pasty consistency filler is too thick to be even brushed and that to spray it is out of all reason; yet, I have actually been spraying filler for many years.

The saving in cost does not count so much in the labor of application as it does in the labor of sanding afterwards. A cross-section of a surface filled with a brush would look like Figure 11-A, while the same surface sprayed with a large nozzle would look like Figure 11-B.

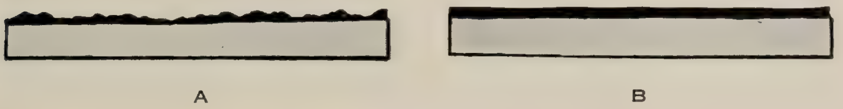

Figure 11—Cross-Section of Filler Coats

Obviously the brushed surface will have to be *cut down* to the lowest *furrow* in order to get a smooth surface. This means that much of all the filler applied has to be again taken off by the slow, laborious method of hand-sanding.

Bear in mind that an application of brushed or sprayed filler will neither fill up holes, nor cover rough portions of the surface, hence a coating of uniform thickness all over the surface is the result. Some manufacturers try to eliminate the putty operation entirely and expect the filler to do for both operations, while a few makers of filler material unthinkingly advocate the use of their product as either a putty or a filler.

Depending on the class of work one or two coats of baking iron filler may be used. This is not so in the case of air-dry filler coats, which often require the application of four or five coats. It is customary, in the use of air-dry coats, to smooth out the rough surface of the filler prior to sanding by softening the surface with a brushing of turpentine, after which a novel smoothing operation is introduced by brushing the surface with a piece of thick, but very flexible sole leather. However, in the case of baking iron filler, where the coat has to be subjected to several bakings, this should not be done.

VII

BAKING VARNISHES

VARNISH
SHORT OIL AND LONG OIL TERMS
ELASTICITY
BODY
SPECIFIC GRAVITY
FLASH POINT
VISCOSITY
BAKING VARNISHES
INSULATING VARNISHES

VARNISH is from the Latin *vernix,* and the Italian *vernice.* It is a transparent fluid applied to surfaces for the following reasons:

1. Improvement of appearance.
2. Protection of surface.
3. Exclusion of moisture, gases, salts, and so forth, from japanned or colored surfaces.

There are many—possibly 300—different kinds of standard varnishes and an infinite number of special varnishes. The standard kinds are broadly classified into oil and spirit varnishes. In general, varnishes consist of:

1. A transparent pigment in the form of a fossil resin or gum.
2. A drying oil (usually vegetable).
3. Metallic driers.
4. A reducer.

The oil varnishes require heat in the process of making while the spirit varnish may or may not. Table 6 shows a comparison of some of the more popular grades.

The luster is one of the chief characteristics of varnish and this quality increases and decreases, depending upon the amount of gums or resin used; the amount and the kind of drying oil used also affects the luster. Varnishes are not durable or hard unless subjected to chemical treatment at high temperature. In the case of color varnishes this treatment also affects the shade or degree of color.

There is much misunderstanding and mystery about the contents of varnish and the formula for them. Some large users even go so far as to give the manufacturer a formula that he shall use in mak-

TABLE 6

VARNISH TABLE

GRADES AND NAMES	INTENDED USE	DRIES DUST FREE IN HOURS	READY FOR USE IN HOURS	QUALITIES				
				WEARING	LUSTER	RUBBING	WATERPROOF	POLISH
Spar Varnish Exterior Finishes	All surfaces exposed to weather	3–6	48–56	Durable Elastic	Full Deep	No	Yes	No
Interior Finish	All interior woodwork	1–3	24–36	Durable Elastic	Good	Yes	Yes	Yes
Floor Finish	Floors	3–4	24–48	Durable Elastic	Good	Yes	Yes	Yes
Interior Rubbing Varnish	Wherever interior woodwork requires a rubbed finish	2–3	36–48	Hard and Tough	Fair	Can be in 36 to 48 hours	Yes	No
Flat Varnish	Where imitation rubbed finish is desired	1–2	18–24	Hard	No	No	Fair	No
Hard Oil No. 1 Coach, Interior Gloss Coach	Interior woodwork where gloss finishes (not expensive) are required	1–4	16–20	Fair and Good	High	No	No	Fair
Orange Shellac White Shellac	Quick use on woodwork and sealer over water and oil stains	1-3	¾	Good	Good	No	No	Yes
Damar Varnish	In enamels and on white work where transparency is important	10–14	48–56	Fair	Good	No	No	No
Polishing Varnish	Interiors, pianos, Furniture—wherever high polish is desired	2–4	48–56	Hard and Durable	High	48-56	Yes	Yes
Automobile Finishing, One coat Coach Flowing Varnish	Last coat on automobiles	6–10	48–60	Durable Elastic	Full Deep	No	Yes	No
Gear Varnish	Last coat on wheels and underparts of automobile	2–6	48–56	Durable Elastic	High	No	Yes	No
Automobile Clear and Black Rubbing Varnishes	Surface builders on automobile bodies for finishing or flowing varnishes	4–6	48–56	Durable Hard	Fair	24–48 Good	Yes	No
Mixing Varnishes	To mix with pigments for color varnishes without curdling or separation	4–6	24–48	Fair	Good	Fair	Fair	No
Baking Varnishes or Baking Copals	A clear preservative baked on metals as last coat	2–3 in oven	1–6	Good	High	Yes	Yes	Yes
Furniture Rubbing and Furniture Rubbing and Polishing	Furniture where a rub or polished finish is desired	3–6	48	Good	Fair	24–48	Fair	Yes
Dipping Varnishes	A quick-drying preservative for cheap work	1–3	12–18	Fair	Good	No	Yes and no	No
Air Drying or Dipping Black Varnishes or Asphaltums	A cheap quick drying preservative for iron or steel	½ to 3	6–24	Fair	Good	No	Yes	No
Sizing Varnishes and Gloss Oils	First coat on newly plastered walls—stops suction and kills lime action on wall finishes	½ to 2	6–12	Good Binders	Fair and Good	No	No	No

ing the goods they order. How ridiculous, when one considers that the raw materials used vary widely, depending upon the time of the year they are grown; the part of the world that they are grown or found in; and the conditions under which the materials are cooked. As a matter of fact, a formula is only a *guide* for the varnish maker. Indeed, he could not make two batches of varnish *exactly* alike. Therefore, the customer's salvation in getting satisfaction with varnishes is the selection of a reputable varnish manufacturer. Some varnish-makers excel in one kind of varnish and some in another. In other lines recourse is made to chemical analysis for assurance of uniformity, but in the case of varnishes the japanner has very little hope because the chemical character of the raw materials is changed entirely when the heat treatment is applied.

Obviously it is not proper to add oil to varnish in the workshop to change the character, since the oil can only be compounded with the varnish chemically and then only by heating.

SHORT OIL AND LONG OIL TERMS in describing varnishes are sometimes confused. Maximilian Toch says:

> The heavy boiled oil, from which the varnish is made is by partial oxidization, blowing or partial heating. To test them place a small amount between the thumb and forefinger and rub rapidly. If short threads are formed it is a short-oil varnish, while if long threads are formed it is a long-oil varnish. The short-oil material is short lived and the long-oil is long lived, because the short-oil has been highly oxidized and continues to oxidize after it is dry.

According to Scott the *short-oil* varnishes usually contain from five to eleven gallons of oil. They are used as furniture, rubbing and polishing varnishes, where a high degree of luster, hardness and quick drying are more essential than durability.

The medium-oil varnishes, contain 12 to 24 gallons of oil. They are used for interior and architectural finishes, hard oil, cabinet and floor varnishes. In this grade, luster, hardness, fullness, and a fair degree of durability are desired.

The *long-oil* varnishes, designed for exterior use where durability is the main feature, usually contain from 25 to 50 gallons of oil per 100 pounds of gum. This class includes railway, carriage, and implement coach varnishes.

Elasticity of a varnish is due chiefly to the oils in it. Sometimes certain gums are added to improve the quality.

Body may roughly be tested by noting the speed of passage of an air bubble in a long narrow bottle when it is quickly inverted. There are special laboratory instruments for determining this feature where accuracy is desired.

Specific Gravity is determined by using an hydrometer which compares a certain volume of the varnish with an equal volume of water at the same temperature. Varnish being lighter than water a type of hydrometer for *light liquids* should be used.

Flash Point of a varnish is a barometer of its volatility. A low flash indicates rapid evaporation of the volatile thinner. Since the railroad companies require certain labels on shipments it is well to know these are determined by the manufacturer. The late Mr. Geo. B. Heckel in his Varnish Catechism explains it as follows:

> The *flash point* is taken in a metal cup of special form, provided with an arrangement for heating from beneath through a water bath and with a thermometer, the bulb of which is immersed in the liquid under test. The flame of the taper is passed at specified intervals (usually at every rise of three or five degrees in temperature) across the mouth of the cup at a distance of about ½ inch from the surface of the liquid. The point of temperature at which the evolved gases ignite is the flash point. The rise in temperature of the liquid should not exceed 15 degrees per minute. Scott has described a home-made flash-point apparatus which is cheap and efficient. He suggests a common three-inch wrought-iron crucible, a six-inch sand bath, an ordinary retort stand, a Bunsen burner or alcohol lamp, and a cheap chemical thermometer. Place the sand bath on the lower ring of the retort stand and cover its bottom with an inch or less of fine sand, on which set the crucible, half filled with the varnish to be tested; suspend the thermometer so that its bulb is immersed but does not touch the crucible. Raise the heat carefully so that the rise in temperature is regular and does not exceed 15 degrees per minute, remove the burner from time to time as may be necessary to maintain this rate. At every rise of three or five degrees bring a lighted match or taper not nearer than one-half inch from the surface of the varnish. When a distinct flash occurs, note the temperature, which is the flash.

Viscosity of a varnish, which is the measure of its flow, may best be ascertained by use of a viscometer. The *viscosity* of varnish is often incorrectly referred to as its *body, thickness,* or as *heavy* and *light,* as the case may be, but as such it has no real value.

Baking Varnishes would, of course, interest the japanner most. Because of the more thorough and uniform oven-drying treatment they are more durable then air-dried interior varnishes.

The freshly applied varnish film consists of a volatile thinner and non-volatile oxidizable oils, gums and, in case of pigmented enamels, also mineral and organic colors. When the coated article enters a heated oven, the absorption of heat causes the volatile solvents to evaporate. The temperature of the surface film remains at or slightly below the boiling point of the solvents as long as these are present.

When the evaporation process has ceased, air being no longer restrained by the escaping vapors begins to oxidize and harden the oil film. Simultaneously, due to the action of heat, polymerization of the oils takes place, which accounts for the harder and more durable surface of the baked as compared with air-dried finishes. The reactions of oxidation and polymerization become extremely rapid at elevated temperature.

Insulating Varnishes were deficient in many ways in the earlier varnishes used in electrical work. Originally they were air-dried. The insulating values were not high and the air-dry method gave no control over the results. The *body* might vary considerably and furnish but poor support for the conductors. There was no way of telling just how quickly the varnish had dried sufficiently to make safe use possible.

The modern compounds of varnishes and baking methods have reduced the insulating problem to almost an exact science. The best of these varnishes provide an excellent insulator and the desired mechanical support for conductors, while retaining a proper amount of elasticity, and resistance to moisture or oil.

It is characteristic of baking varnishes that the absence of chemical drier gives them more flexibility than air-dry varnishes. With the exception of spirit varnishes, baking is usually required to make a varnish oil-proof.

Yellow or clear varnishes give a harder film and better mechanical protection, but black varnishes, with asphaltic material added to the drying oils, are superior in nearly all other respects.

The modern oven (Figure 12) used for preliminary drying and the final baking of coils, and so forth, gives uniformity of temperatures and positive control of ventilation and heat circulation. This permits one to pre-determine just what results will be secured by applying the proper temperature and time of bake. By varying these the characteristics of varnish can be modified within certain limits. This baking greatly speeds up the drying process and also reduces it to a definite factor in production. Preliminary baking is done to drive out moisture so that the varnish or insulating compound may penetrate properly. Under-baking, means a varnish coat not properly oxidized. On the other hand, over-baking tends to weaken the insulating cloth, paper, and so forth. It may even kill the varnish itself.

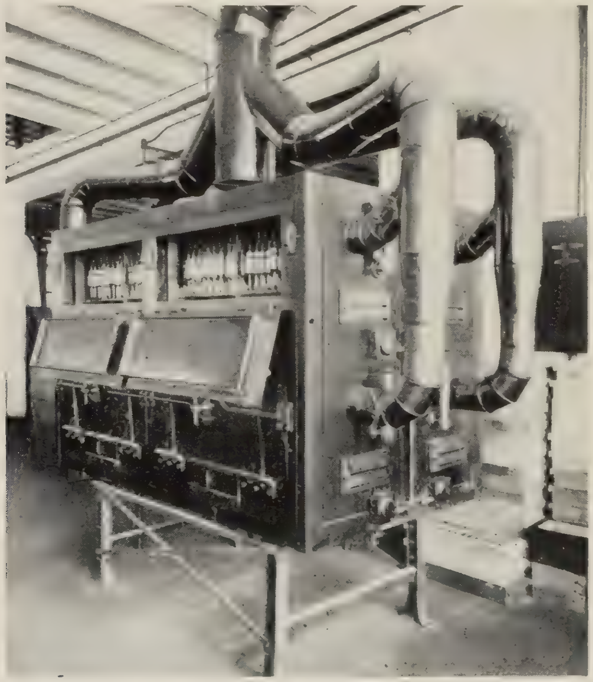

Figure 12—A Four-compartment Insulating Varnish Oven

Ovens should remove moisture or volatiles, and distribute fresh hot air at even temperature to the product being baked. Radiation and convection of heat to the load should be quickly accomplished but well under control. Small coils and large armatures may follow each other in the same oven. Where production is large, special ovens are sometimes needed to care for a particular class of work.

Requirements in time and temperature for insulation baking differ greatly from those used in japanning. Yet good ventilation and uniform supply and distribution of heat are needed alike in both. Hence, typical ovens are suited for combination work.

VIII

SHOP-CLEANING EQUIPMENT

The Capacity of Rectangular Tanks
The Capacity of Cylindrical Tanks
The Size and Length of Heating Coils
Gas-heated Cleaning Tanks
Sheathed Gas-heated Tanks
A Direct-connected Fan Blower
Steam-heated Cleaning Tanks
The Operation of Cleaning Tanks
Dipping Baskets
Compressed-air Agitators
A Production Cleaning Machine

The Capacity of Rectangular Tanks may be ascertained by multiplying the length by the width by the depth and the result thus obtained by 7½. (1 cubic foot equals 7½ gallons.)

Example—What is the cubical contents of a tank 8 feet long, 4 feet wide, and 2½ feet deep?
8 x 4 x 2½ = 80 cubic feet. How many gallons will this tank hold?
80 x 7½ gallons = 600 gallons.

Other important information will be found in Table 7.

Table 7

Rectangular Solution Tanks (Gas Heated)

Inches			Capacity Gallons	Approx. Gas Consumed in Cu. Ft. per Hour	Time in Minutes to Raise from 62 Degrees F. to 212 Degrees F.	Approx. Shipping Weight Pounds
Length	Width	Depth				
24	18	18	33.66	125	52	330
30	18	18	42.30	125	60	370
36	18	18	50.49	165	65	452
24	24	24	59.84	185	65	448
30	24	24	74.80	210	75	500
36	24	24	89.76	240	75	550
48	24	24	119.68	300	80	655
60	24	24	149.62	350	90	760
72	24	24	179.54	410	105	860
72	24	30	224.42	510	90	900

THE CAPACITY OF CYLINDRICAL TANKS may be ascertained by squaring the diameter, multiplying by .7854 and then multiplying by the length or depth.

> EXAMPLE—What is the capacity of a cylinder 4 feet in diameter and 6 feet in length?
> 4 x 4 x .7854 x 6 = 75.3984 cubic feet.
> How many gallons will it hold?
> 75.3984 x 7½ = 565.49 gallons.

The tanks required will naturally vary in size and character with the amount, size and nature of the work to be handled as well as the heating facilities available.

THE SIZE AND LENGTH OF HEATING COILS for use in cleaning tanks is important since it is very easy to underestimate the amount needed.

TABLE 8

SIZE AND LENGTH OF PIPE FOR HEATING COILS
(IN FEET PER GALLON)

HOURS REQUIRED FOR HEATING FROM 62° F. TO 212° F.	INSIDE DIAMETER PIPE IN INCHES	VARIOUS STEAM PRESSURES IN COIL IN POUNDS PER SQUARE INCH					
		3	10	25	50	100	150
½ hour	½	*1.524	.826	.602	.452	.332	.270
	¾	1.150	.624	.342	.342	.250	.204
	1	.904	.490	.268	.268	.195	.160
	1¼	.688	.374	.204	.204	.150	.122
	1½	.588	.320	.174	.174	.128	.104
	2	.460	.250	.136	.136	.100	.082
	2½	.386	.210	.114	.114	.084	.068

*Divide these figures by 2 if the time for heating is 1 hour. Divide these figures by 4 if the time for heating is 2 hours.

Here is given (Table 8) the length in feet of steam coil per gallon of tank capacity for various steam pressures, pipe sizes, and time allowances. The first column gives the time in which the tank is to be heated. The second column gives the diameter of the pipe to be used in the coil. The figures at the top in the third column indicate the pressure of steam that is to be used to heat the tank.

To figure the length of pipe required to make a coil to heat a certain tank the following information is needed:

1. Approximate allowable time to heat the tank.
2. Diameter of pipe to be used in making the coil.
3. Pressure of steam to be used in the coil.
4. Capacity of the tank in gallons.

EXAMPLE—Find the size of coil required to heat a 375 gallon tank in ½ hour using 2 inch pipe and steam at 25 pounds pressure. From Table 8, the length of pipe in feet per gallon is .136 feet.

375 x .136 = 51 feet—the total length of the 2 inch heating coil.

GAS-HEATED CLEANING TANKS may be used by many japanners who now clean with gasoline because steam is not available. Where there is no gas supply, a coal-fired water heater, of which there are many makes and types, gives excellent service at a very low cost.

A common error is to install a heater that is too small. Data as to tank capacity, length of time to bring solution up to working heat should be furnished to the manufacturer and his recommendation followed. An oversized heater will bring the temperature of the solution up quickly and the gas can then be turned down, but an undersized heater is a constant source of annoyance. More than one heater can, of course, be coupled to a tank.

The upper connection (flowing from the heater to the tank) should be well below the normal surface of the solution. The lower connection (flowing from the tank to the heater) should be six inches above the tank bottom to avoid clogging. In a multi-coil heater the capacity of the connections should equal the combined capacity of the heating coils. Where the heater is not of the coil type the connections should be as large as the heater fittings will permit, in order to secure free circulation.

For economy of fuel and time such tanks should be insulated to prevent excessive radiation. The insulation also keeps the tank warm during the night, requiring less time and fuel to bring it up to heat the next morning. A hinged tank cover is also a great saver of heat.

SHEATHED GAS-HEATED TANKS are desirable because of time saved in heating up, the higher heat obtained, and the smaller consumption of gas to secure and maintain this heat will more than compensate for the increased cost of sheathing.

The burnt gases escape (Figure 13) through 1½-inch vents spaced at 6-inch intervals in the sheathing, around all four sides. In this manner five heating surfaces are obtained instead of one. The gas from these vents is not objectionable. The number and size of the vents have to be adjusted to the burner capacity and bottom draft.

Where use of the tank early in the day is desired it is advisable to install more burners than are normally required. The additional burners save valuable time in bringing the tank up to heat. After the heat desired has been obtained it can be maintained with one or two burners.

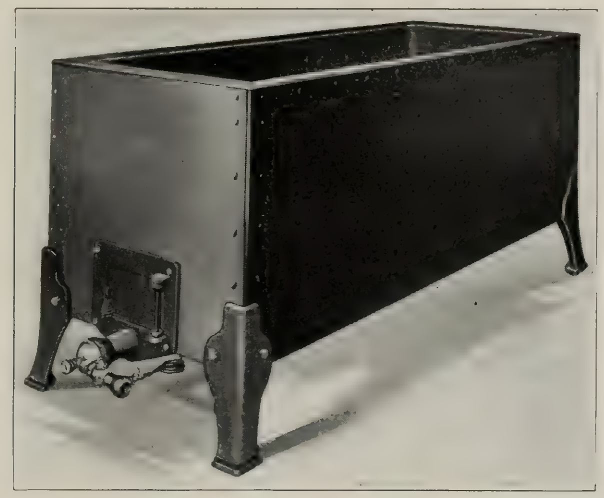

Figure 13—Rectangular Cleaning Tank
(Gas-heated and Sheathed)

A Direct-connected Fan Blower[1] is useful for forcing the draft when it is required to heat the contents of the tank heaters quickly, or when the work is really heavier than an ordinary atmospheric burner is able to handle effectively. The threaded outlet of this one is two inches in diameter, the motor operates at a speed of 3,400 r.p.m., and the outfit is capable of delivering any mixture pressure up to four inches of water column. The blower is universal as to discharge; i. e., if so ordered, the discharge may be horizontal, either above or below the motor, or it may be vertical, either upwards or downwards. The means by which this can be accomplished is readily seen from the cut. Thus it is possible to place the blower in any convenient location.

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[1] See Figure 78, page 158.

STEAM-HEATED CLEANING TANKS which may be either welded or riveted are illustrated in Color Plate I—also the proper location of such fittings as have been found in actual practice to be most useful is shown. The size of such a tank, of course, will vary with requirements.

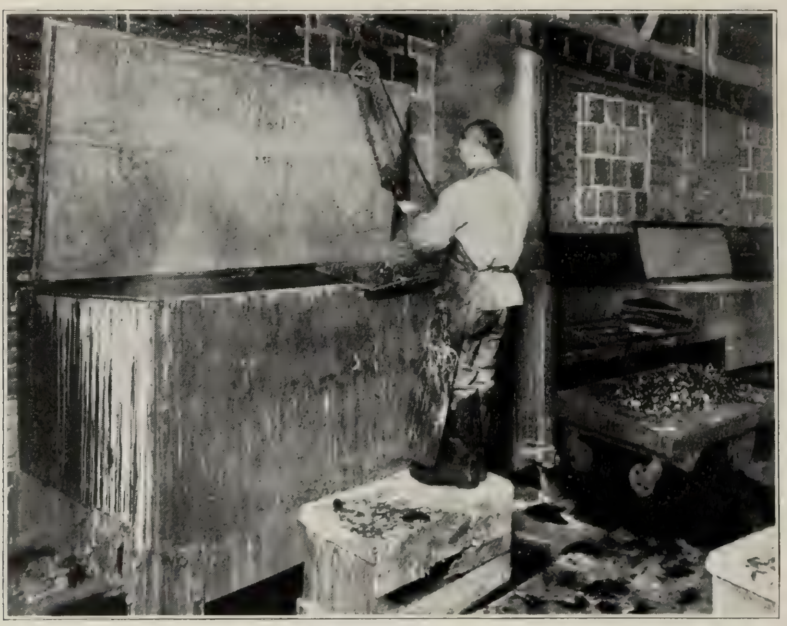
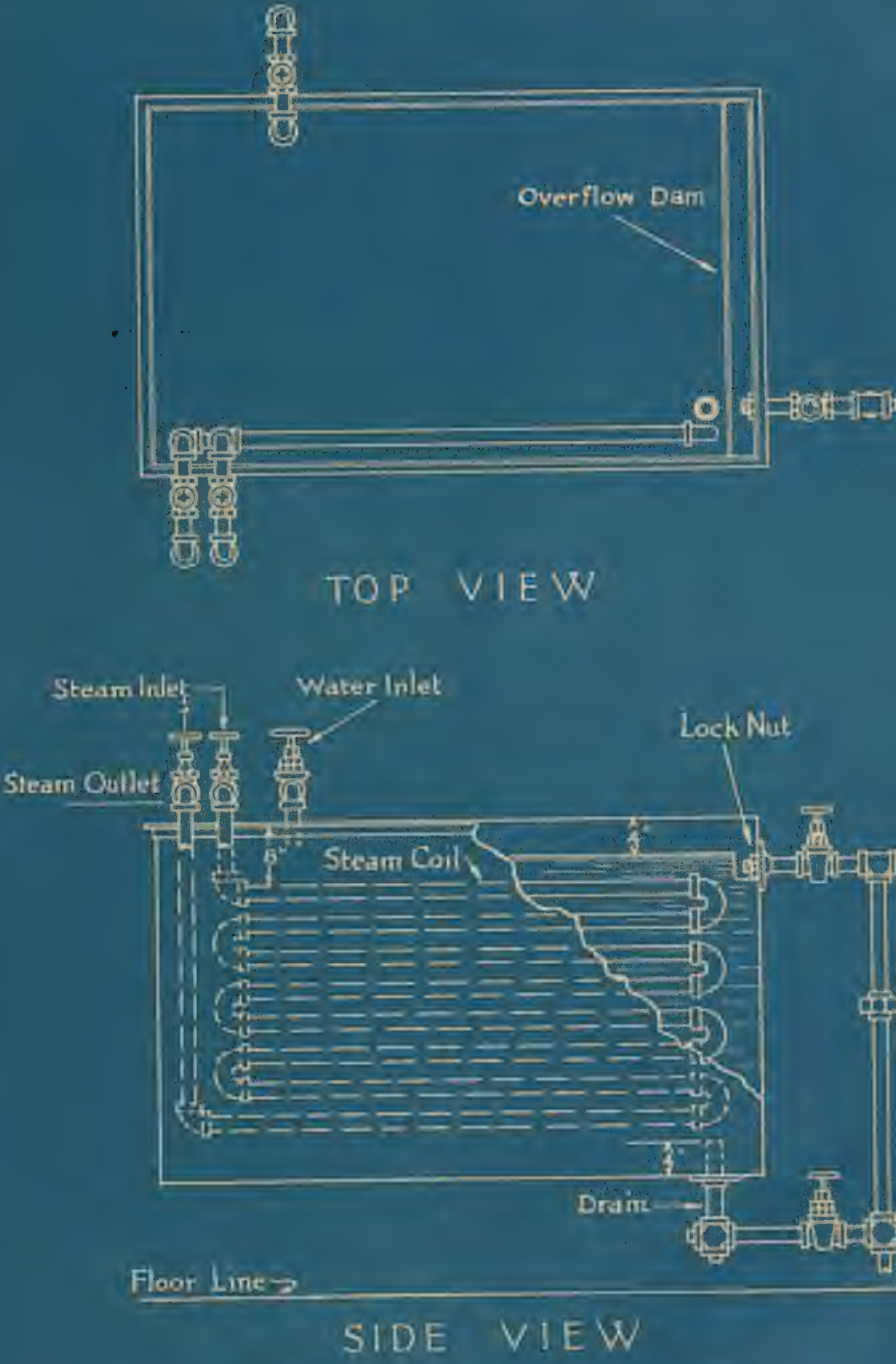


Figure 14—A BUSY CLEANING TANK IN OPERATION

The steam coil should be closed and placed along the front side so that the circulation induced by it will carry the surface oil away from the tank, leaving an oil-free surface through which the cleaned work may be withdrawn. Steam coils should never be placed on the bottom of a tank. They rapidly become covered with dirt from the work and their heating efficiency reduced. Also, the removal of dropped parts is very difficult.



Color Plate I — A Steam-heated Cleaning Tank

The oil overflow dam insures that cleaned work remains clean, which is impossible if the surface of the solution is covered with dirty oil. Such a dam does away with the frequent skimming that is otherwise necessary. The dam shown is a U-shaped sheet-metal trough welded to the tank at each end. The overflow pipe joint is made tight with a lock nut and gasket. This dam should, of course, be level.

Into the drain fitting, in the tank bottom, is loosely screwed a 4-inch to 6-inch nipple. When emptying the tank, the bulk of the solution can be drawn off with this nipple in place, without disturbing the dirt on the bottom. The dirt, if it is heavy, can be shoveled out, the nipple removed and the tank bottom flushed with water. With such a procedure the drain pipe will not become clogged. Cross-tees with plugs are used in drain-pipe connections. These plugs can be removed and the line cleared in case of clogging.

The Operation of Cleaning Tanks (Figure 14) demands close attention for best results. They should be thoroughly cleaned before adding cleaning compounds. They should be heated with a steam coil rather than with live steam, as continued dilution due to condensation is wasteful. The cleaning solution should be maintained at approximately 200 degrees F. A little additional heat costs less than the time wasted by slower washing.

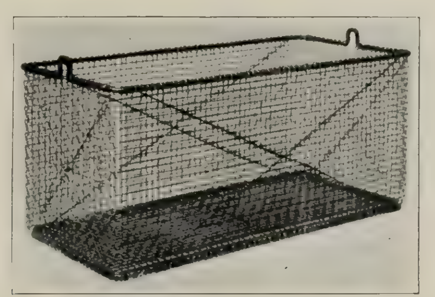


Figure 15—A Dipping Basket

Dipping Baskets may be any size or shape providing they will enter the cleaning tank. The size of mesh should be chosen to fit the particular case in hand. The basket may even be made of perforated metal. A wire basket having the top entirely free to receive

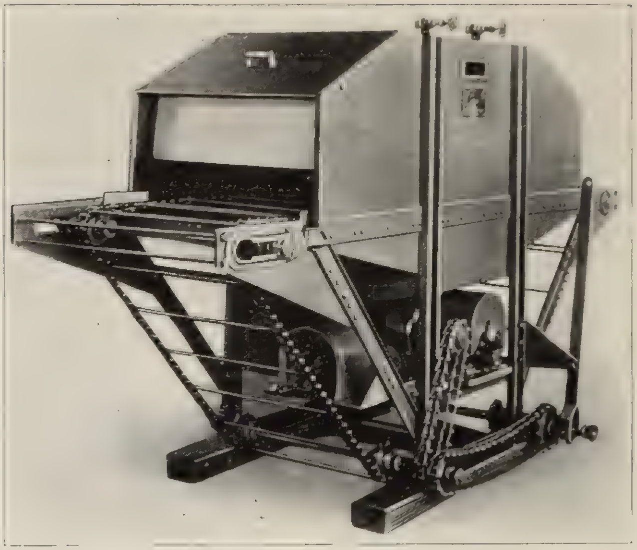


Figure 16—An Automatic Washing Machine

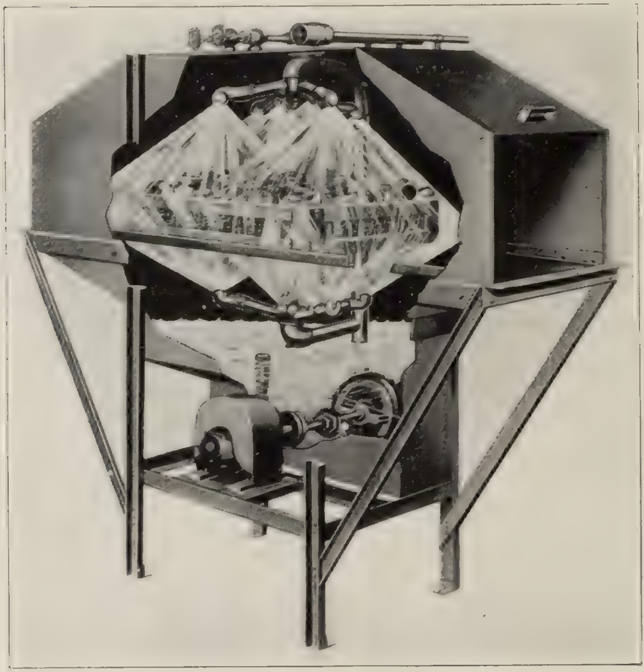


Figure 17—An Automatic Washing Machine (Phantom View)

parts as shown in Figure 15 and supplied with two handles is suggested.

Compressed-air Agitators are a great help where the accumulation of grease on large parts is heavy, or specially difficult to remove. As the cold air cools the solution itself, care should be taken to adjust the flow so that a temperature of at least 150 degrees F. can be maintained. If a single agitation pipe be installed along the bottom on the side nearest the operator a circulation will be obtained which will cause the scum to collect on the side away from the operator, thus leaving a clean solution surface in which to work.

A Production Cleaning Machine (Figure 16) is needed when the volume of work becomes too great a burden for one or two men to handle in stationary tanks. Here the parts are placed in baskets and are carried through the machine on a slow-moving conveyor.

A phantom view (Figure 17) of this automatic machine shows how the hot cleaning solution is sprayed-on from above and below. Note that the cleaning-solution tank is at the bottom and when the pump operates the spray is in action. All the waste falls directly back into the cleaning tank below.

It is desirable in most cases to have one of these machines for the cleaning solution and one for the rinsing water.

IX

SAND-BLAST EQUIPMENT AND ITS OPERATION

Sand-blasting
Air Consumption
Sand Flow
Clogging the Apparatus
Tonnage that Can Be Sand-blasted
The Direct Pressure Sand-blast
A Sand-blast Room
Sand-blast Cabinets
The Open-hopper Sand-blast
Sand-blast Barrels
Suction Feed Sand-blast Barrels
The Table-type Sand-blast
Cloth-screen Dust Arresters
Results of Actual Tests

Sand-blasting is one of the best known processes for removing the scale from castings and from all sorts of metal goods, preparatory to nickel-plating, galvanizing, sheradizing, oxidizing, japanning, rust-proofing, painting, and so forth. These coatings in general adhere to sand-blasted castings very firmly and will not peel off. It is not necessary to pickle sand-blasted castings.

Pieces treated by sand-blast are cleaned in all holes and crevices more thoroughly than can be done by hand or any other method. Sand-blasting does not disfigure ornaments and does not round off sharp edges. Gray-iron, steel, and malleable castings and forgings cleaned by sand-blasting have a very even color, giving them better appearance. Different abrasives give different colors. Bronze and brass goods treated by sand-blasting have an even surface of fine

Table 9

Volume of Free Air Discharged into the Atmosphere (Through a Round Orifice)

Diameter of Orifice in Inches	Air Tank Gauge Pressure in Pounds Per Square Inch											
	2	5	10	15	20	30	40	50	60	70	80	90
1/64	.04	.05	.08	.10	.12	.15	.19	.22	.26	.29	.33	.36
1/32	.15	.24	.34	.41	.48	.63	.77	.91	1.05	1.19	1.33	1.47
1/16	.64	.96	1.36	1.67	1.93	2.52	3.07	3.64	4.20	4.76	5.32	5.87
1/8	2.43	3.86	5.45	6.65	7.70	10.00	12.27	14.50	16.80	19.00	21.20	23.50
1/4	9.74	15.40	21.80	26.70	30.80	40.00	49.09	58.20	67.00	76.00	85.00	94.00
3/8	21.95	34.60	49.00	60.00	69.00	90.00	110.45	130.00	151.00	171.00	191.00	211.00
1/2	39.00	61.60	87.00	107.00	123.00	161.00	196.35	232.00	268.00	304.00	340.00	376.00
	These values are in cubic feet of free air per minute											

grain, giving the pieces an attractive appearance not obtained by any other process. White silica sand should be used.

There are three general methods of sand-blasting: direct pressure, gravity, and suction. The latter is often called the syphon method.

Air Consumption is governed by the size of the nozzle and pressure maintained. Table 9 gives the air-flow of different nozzles at varying pressures.

TABLE 10

SAND FLOW THROUGH NOZZLES

Nozzle Opening in Inches	Hose Internal Diameter in Inches	Sand Flow in Pounds per Hour at 80 Pounds
3/16	3/4	500
1/4	3/4	900
5/16	1	1,300
3/8	1 1/2	1,700
1/2	1 1/2	3,000

Sand Flow or the behavior of especially made abrasives such as shot of various sizes and forms should be known in order that the necessary supply of cleaning material may be available when needed. An idea of the sand flow will be found in Table 10.

There are several different grades of sand and perhaps 20 or 30 different kinds of steel shot, grit and other suitable abrasives.

Clogging the Apparatus is prevented by the removal of moisture from the compressed air which passes through a moisture separator before entering the machine and the hose line. The screen through which all the abrasive material is passed before entering the sand tank is mounted on a frame directly above the filling valve. This allows quick filling without the use of a pail or funnel.

Care should be taken to screen the sand before it enters the tank so that no single grain will clog the nozzle. As a guide for the size of mesh to use in screening it is well to use one that will exclude all grains that are larger than one-third the diameter of the nozzle that is being used.

It is not the visible flow of sand from the nozzle that gauges effective work. Rather, the *blue flame* or *striking fire* effect accompanied by an almost imperceptible flow of sand indicates the efficient operation of a sand-blast as it strikes the surface that is being cleaned.

TONNAGE THAT CAN BE SAND-BLASTED economically is, of course, a very important thing to know. It naturally varies with different conditions of work, nozzle size and pressure maintained. It is almost impossible to give even an approximate estimate without a close knowledge of the work to be cleaned.

For instance, each machine may be equipped with nozzle openings from 3/16 inch to ½ inch or even ¾ inch or 1 inch under low pressures. A 3/16 inch nozzle operating under 80-pound pressure consumes 45 cubic feet of free air per minute and blows approximately 500 pounds of sand per hour. A ½ inch nozzle, under 80-pound pressure, consumes 340 cubic feet of air per minute and blows approximately 3,000 pounds of sand per hour. Should these two nozzles operate at the same time on the same class of work, the machine equipped with ½ inch nozzle would perform approximately eight (8) times as much work in a given time as the 3/16 inch nozzle.

While the nozzle size should be adapted to the character of the work in hand, it is limited by the volume of air available and in turn this will govern the size of the abrasive that can be used which must, of course, pass freely through the nozzle used. The abrasive that flows most freely will in its individual grains be not larger than ⅓ the diameter of the nozzle used.

A ¼ inch nozzle on small or medium gray-iron castings is capable of cleaning from five to six tons per 10-hour day. As to the most economical pressure for operating a sand-blast, this varies greatly with the individual conditions at the plant, the grade of the abrasive and the character and condition of the work. Generally speaking, above 80 pounds pressure gives best results on steel castings; gray iron from 80 to 60 pounds; brass and aluminum work will clean cheaper at lower initial pressures. Thin sheet steel, such as that used for automobile bodies, and so forth, sometimes has to be cleaned at a pressure lower than the best efficient cleaning pressure, so as to avoid warping the materials. On very thin material, a pressure as low as five pounds pressure is used.

The Direct Pressure Sand-blast is a sealed container fitted with a mixing chamber to which is attached a hose with a nozzle at the end. Air is introduced into the tank above the abrasive at the same pressure that is being used through the hose and the nozzle.

The air on top of the abrasive equalizes the pressure in the tank and permits the abrasive to flow to and through the mixing chamber by gravity, thus reducing wear and tear on these parts to a minimum. An abrasive feed control permits the regulation of the sand flow from the tank to the mixing chamber to suit the size of nozzle that is being used and the character of the work done.

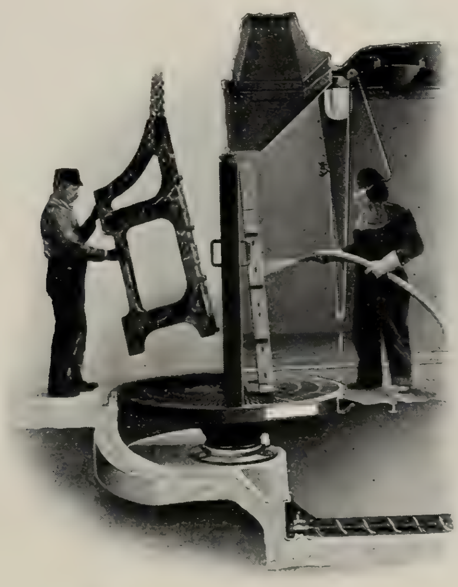


Figure 18—A Sand-blast Room

A Sand-blast Room installation overcomes objectionable dust feature for the japanner. If this be installed (Figure 18) not only will the dust be eliminated, but the sand can be used over and over again, so that sand-blasting will be efficient and economical.

Air enters the room through an air inlet in the ceiling, is drawn downward and the dust-laden air exhausted near the floor into the ducts at the side of the room. The sand used falls through the perforated floor and is carried through a worm-conveyor to an elevator which returns it to the sand-blast machine.

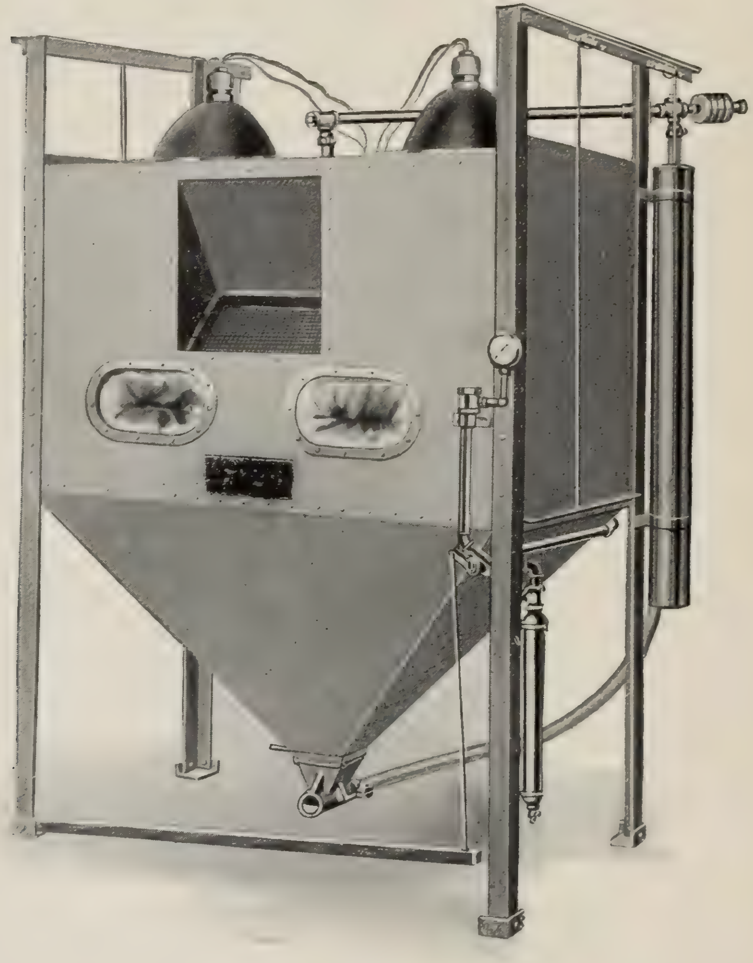


Figure 19—A Sand-blast Cabinet

The rotative table does not, however, rotate continuously but at intervals whenever desired. The center is in line with a wall of the room and may be turned 180 degrees from time to time. This table is divided into two sections by a vertical partition which becomes a part of the room wall. After the outer half has been covered with castings to be cleaned, it is turned inward. After the operator has blasted these castings, the other half, which in the meantime has been covered with new castings, is turned inward.

Sand-blast Cabinets may be economically used where the size of the work is not adapted to room or other methods of cleaning. The casing of the cabinet is made of heavy steel mounted on legs (Figure 19). A large door on the side is provided for placing the material into the cabinet, where it is supported on a screen covering the entire floor area of the cabinet. The blasting mechanism consists of a gun specially designed and constructed on the ejector principle.

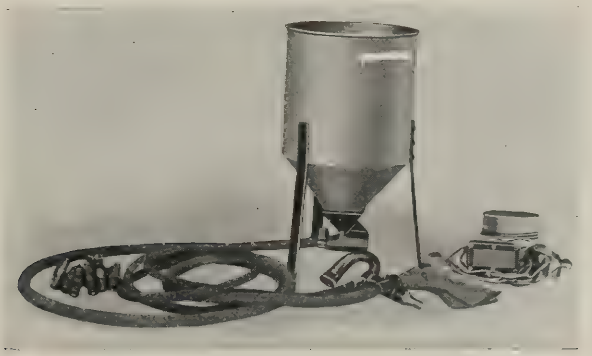


Figure 20—Open-hopper Sand-blast (with Pistol, Headgear and Gloves)

The sand is withdrawn from the bottom of the hopper through a piece of heavy rubber-lined sand-blast hose with four-ply duck to retain the roundness and smoothness of the bore.

The abrasive material is projected from the gun, drops through the screen and is used over and over again until it becomes too fine for sand-blasting purposes and is carried out by the exhaust of the system. A clear vision window is provided in the front of the cabinet. This is hooded over so as to increase the power of the operator's vision. The opening is closed by a glass to protect the operator's eyes and this in turn is protected by a curved screen of fine mesh on the inside to prevent the frosting of the window.

The top of the cabinet is provided with an electric light protected by a glass window directing the illuminating rays upon the work.

Means are provided in the casing of the cabinet for the attaching of an exhaust pipe to clear the dust during the operation. Two openings are provided in the front of the cabinet. These are closed by sleeves having an elastic wrist band and large enough to give free movement to the operator in handling the work. The blast can be started and stopped either by hand or foot. These cabinets can be used for producing mat or velvet finishes on silver, brass and other metals. For removing scale, frosting glass, or other similar work, a pressure not exceeding 15 pounds may be used, but for cleaning gray-iron or steel castings a higher pressure produces a greater volume of work.

There is no wear on the air nozzles and they can be used interchangeably of sizes from 1/8 inch to 3/8 inch in diameter, thus regulating the amount of air used and determining the rapidity and grade of the work performed. However, the sand nozzles do wear and have to be changed quite frequently.

The Open-hopper Sand-blast (Figure 20) is a receptacle having a cone bottom with a feed box at the bottom of the cone. The sand hose from the feed box is connected to one opening of the sand-blast gun. Compressed air is connected to the other opening.

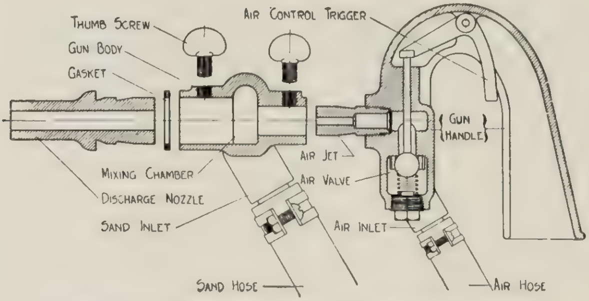


Figure 21—Cross-section of a Sand-blast Pistol

When air is turned into the gun, either by trigger action or valve, a partial vacuum is created in the sand-blast hose which draws the sand into the gun where it is combined with the air and together they are discharged through the sand nozzle.

The best position for holding the pistol is with the nozzle about six inches from the work and at an angle of 45 degrees. A good hard sand thoroughly dried and screened to a grade suitable for the work in hand should be used.

A complete outfit consists of a pistol (Figure 21); sand receptacle; two lines of hose; six nozzles; one hood and one pair of gloves.

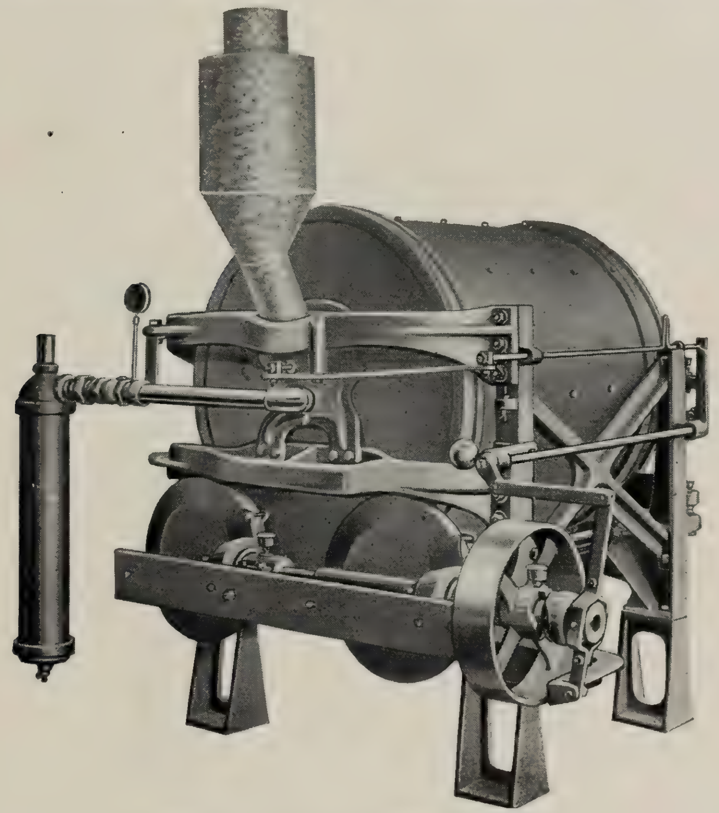


Figure 22—Sand-blast Barrel (Rear View)

Sand-blast Barrels are used for mass production (Figure 22). This illustration shows the outer construction which is stationary. The front view of this same barrel is shown in Figure 23 and this shows the inner or revolving barrel.

The front and side view details are clearly shown in Figures 24 and 25.

The inner barrel (B) is made from heavy sheet steel, one-half inch thick, having a number of holes in it which allows the sand, after coming from the blast nozzle (F) and striking the castings, to fall through the bottom of inner barrel (B) to outer shell (A). As the barrel revolves (direction of arrow) the sand or grit falls into buckets (C) and is carried to the top of barrel where by its own gravity it falls into a nozzle hopper (D) where it is picked up by the compressed air by which it is driven through the nozzle against the work and again passed through the cycle of reclamation as above. This is the gravity type of barrel:

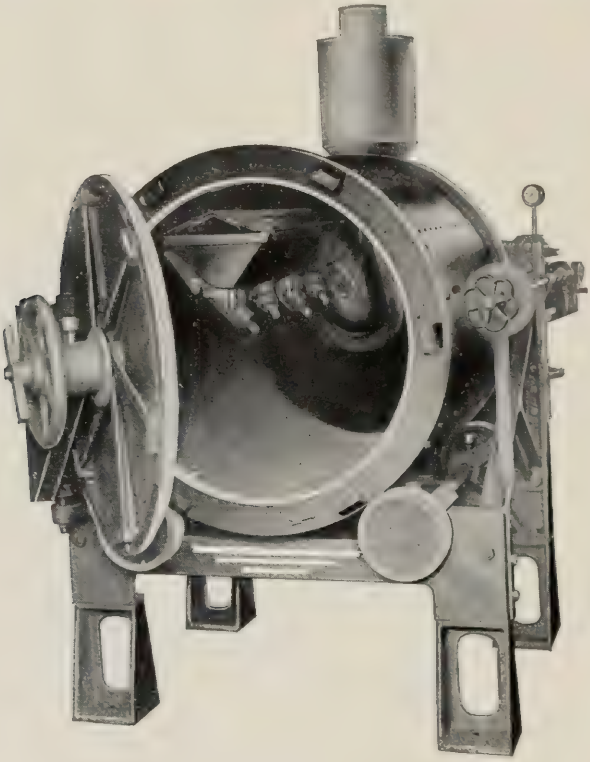


Figure 23—Sand-blast Barrel (Front View, Open)

Other parts are as follows:

E—Screen to remove foreign matter.
G—Exhaust pipe for removing dust.
H—Slide valve in hopper.
I—Cast-steel hopper support.
J—Petcock for drip.
K—Compressed-air inlet.
L—Exhaust outlet.

The blast barrel turns two revolutions per minute, thus diminishing the breakage on the most delicate castings to the smallest degree possible and does not round the edges as is the case sometimes when parts are tumbled with stars.

The door on the front of the barrel is sustained by hinges, making no weight come upon the operator while opening or closing the door. The barrel is operated from the front by three levers: starting, sand, and air, all being within easy reach of the operator. The castings are placed inside the barrel. The sand is placed inside at random and automatically carried to the hopper. If sand is used as a cleaning abrasive it is necessary to replace the sand by adding one or two shovelsful every two or three charges. This is necessary because of disintegration of the sand in sand-blasting which is carried off by the exhaust in the form of dust.

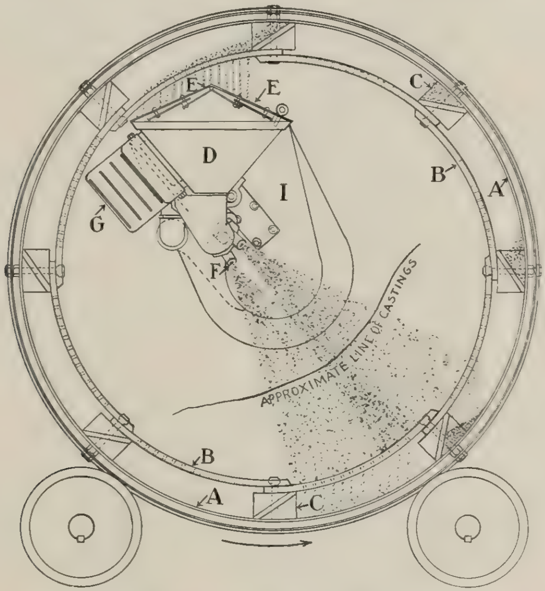


Figure 24—Sand-blast Barrel (Front View, Detail)

The dust is carried off by the exhaust connection (L) at the rear of the barrel. This connects with exhaust chamber (G) inside of barrel running in back of hopper (D) as shown in cut. The exhaust chamber (G) within the barrel has four openings to remove the dust from all parts of the barrel uniformly.

Suction Feed Sand-blast Barrels give continuous operation and are entirely enclosed to protect the operator. The barrel drum is of steel plate perforated the entire area with solid steel-plate heads. The interior is shown in Figure 26, and as the barrel revolves all faces of the work are presented to the blast action. A sheet-steel housing, enclosing the drum, is formed into hopper shape at the bottom for abrasive storage and equipped at the bottom with a feed box to which is attached the abrasive hose by which it is conveyed to the blasting unit, the whole supported on a structural-steel frame.

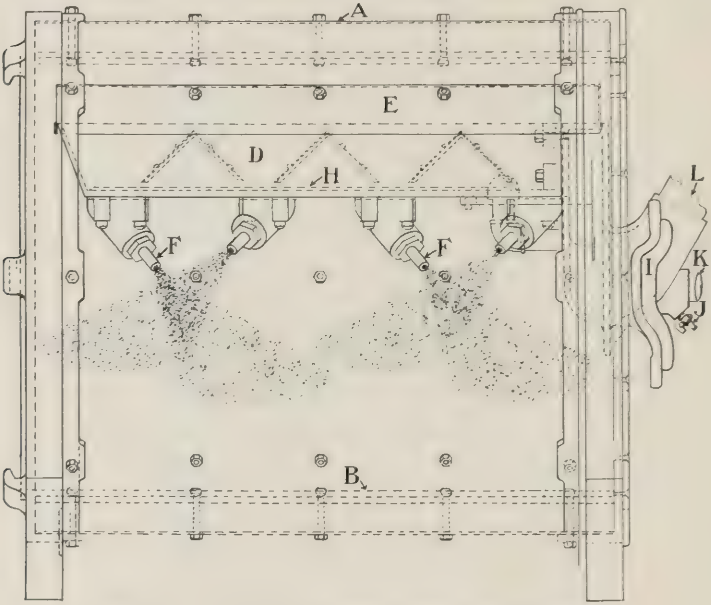


Figure 25—Sand-blast Barrel (Side View, Detail)

The nozzle (Figure 27) of the blasting unit projects through an opening in the side of the drum and is mounted on a swinging door. The barrel drum, supported at one end on a shaft, is slowly rotated by a worm gear reduction, and provided with tight and loose pulleys and belt shifter for starting and stopping the barrel. One-half horsepower is required to drive the machine. The drum mounting and gear is rigidly supported on a bracket integral with the structural work of the barrel housing.

The barrel itself is fitted with a cast-iron door, extending the entire length of the drum, equipped with a double bracket latch.

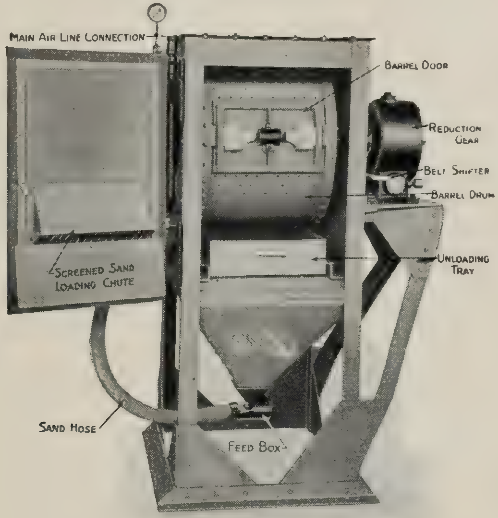


Figure 26—Suction Feed Sand-blast Barrel (Open)

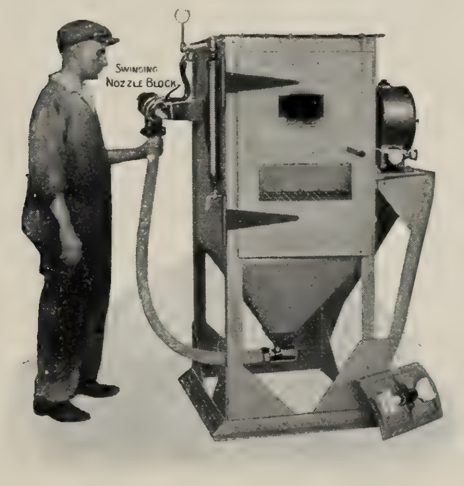


Figure 27—Suction Feed Sand-blast Barrel (Closed)

Beneath the barrel is located a perforated bottom tray for receiving the load, which is dumped directly from the barrel. A dust-tight door encloses the entire front of the housing case, giving free access to the barrel for loading and unloading. A screened air inlet in the door also serves as a loading chute for fresh abrasive. The blasting action, reclamation and handling of the abrasive and dust is thus entirely enclosed.

The Table-type Sand-blast is a very popular form for production work. The mechanism includes a continuous revolving table of suitable diameter. The parts are loaded on the table by a workman who also takes them off after they have passed under the set of properly arranged, continuous sand-blast nozzles.

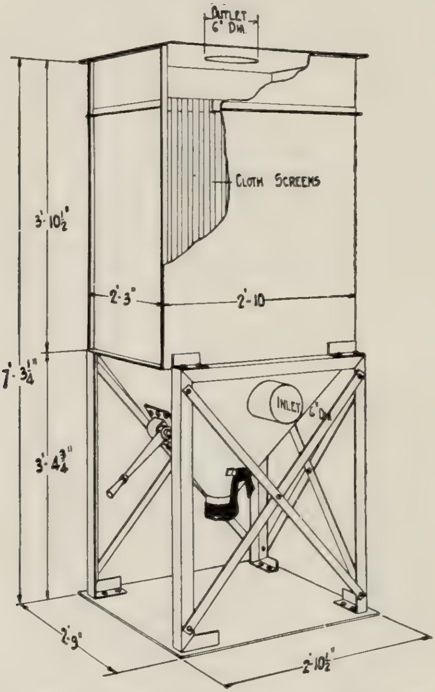


Figure 28—Cloth-screen Dust Arrester (Floor Installation)

Cloth-screen Dust Arresters are a form of dust arrester used to suppress all dust. They have cloth of a texture and closeness to retain the dust and at the same time to give free access to the air. They are designed to provide protection to the screen and make them easily and quickly removable. A pneumatic vibrator directly connected to the screens is used in large sizes, while a hand vibrator is used in the small size.

Capacities of the arresters are carefully figured to provide any number of changes of air per minute desired, and adaptability to installation either within or outside of buildings to meet individual convenience, makes them available for the japanner. The dust-laden air is drawn through the screens and every particle of dust is retained within the hoppers, which are piped for convenient discharge. The cleaned air may be returned to the building or ventilating system. The small arrester may be either suspended from the ceiling or placed on the floor (Figure 28). This type may be had in four sizes in multiples of 700 cubic feet of air per minute capacity.

Results of Actual Tests to ascertain the most effective pressures and distance from sand nozzles for maximum results, were made by Prof. Wm. T. Magruder, of the Ohio State University, Columbus, Ohio, and published by the American Society of Mechanical Engineers, and are quoted as follows:

> With a constant pressure of 60 pounds in the machine, and a fixed distance of eight inches from the sand nozzle to the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it, when the angle between nozzle and the surface of the work was from 40 to 60 degrees.
>
> With a constant pressure of 60 pounds in the machine and a constant angle of 45 degrees between the nozzle and the surface to test bar, the largest amount of metal was removed and the least amount of sand required to do it when the distance from the nozzle to the work was about six inches.
>
> For a constant angle of 45 degrees and a fixed distance of eight inches between the nozzle and test bar, twice as much metal was removed at 56 pounds pressure as at 20 pounds; at 64 pounds as at 30 pounds; and at 72 pounds as at 40 pounds.
>
> With a constant pressure of 60 pounds and a constant angle of 45 degrees between the nozzle and test bar 60% more metal was removed when the nozzle was held at six inches than at ten inches from test bar.
>
> With a constant pressure of 60 pounds and a constant distance of eight inches between the nozzle and the test bar over 20% more metal was removed with the nozzle held at 45 degrees than at 90 degrees to the test bar.
>
> Unless it can be shown that the extra cost of compressing 100 cubic

> feet of free air per hour to a pressure of 70 to 80 pounds per square inch exceeds the cost to compress it to 30 or 40 pounds by the cost of an hour of labor (25 cents) the higher pressures, delivered at an angle of about 45 degrees and a distance of about six inches from the work, are to be preferred for the sand-blasting of cast iron.

These figures, of course, are not universal, but are quoted here to give an idea of what to expect in general.

See Chapter XXI for further information on the use of the sand-blast.

X

PREPARING THE SURFACE

Proper Cleaning
Dusting
Blowing and Dusting
Baking Out
Die Castings
Carbon Tetrachloride
Benzine
V. M. P. Naphtha
Sulphuric Acid
Phosphoric Acid
A Combination of Phosphoric Acid and Alcohol
Caustic Soda
Remover Compounds
To Remove Old Japan
Caustic Potash
Commercial Cleaning Compounds
The Chemical Action
Sodium Carbonate
To Clean Galvanized Iron
Sandpaper

Proper Cleaning is necessary before it is possible to apply a satisfactory finish. Preparing a surface to receive a finish is without question the most important step in the japanning process. The barrier may be rust, galvanizing, dirt, oil, grease, paint, acids, alkalies, and so on without end. Some metals such as aluminum and brass are greasy by nature and for that reason are difficult to finish —especially for the japanner who may not be expert in this line. Some of the cheaper japans are often applied to cast iron or malleable iron directly without cleaning, but even then, either a poor finish is the result or the japanning solution is polluted by continually dipping these more or less dirty parts into it. An attempt will now be made to discuss the various cleaning processes common in japanning shops.

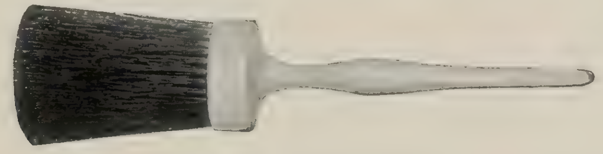


Figure 29—A Bristle Duster

Dusting with a bristle duster is by far the oldest and simplest method of cleaning surfaces that are to be japanned. A long handle on the duster as illustrated (Figure 29) is to be preferred. When used it is customary to *strike* the part rather forcefully with a side motion of the brush.

Blowing and Dusting is a more modern and simpler method of hand cleaning. By the use of a compressed-air duster (Figure 30) the loose dirt will be driven off. This is amplified by a late improvement in this device, which is a combination of compressed-air and bristle duster in one; the bristles loosening the dirt and the air driving it away. This tool may be used only when the dirt is dry and can be blown off. If the dirt is moist or wet, other means must be used.

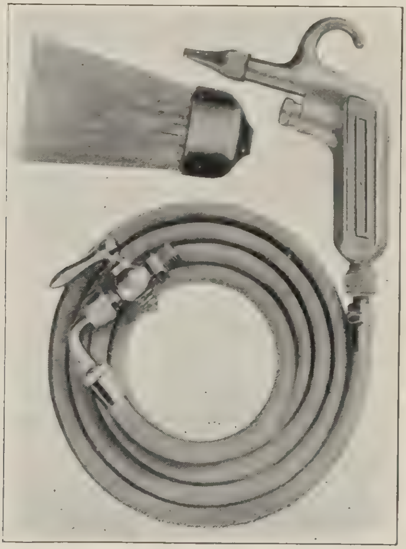


Figure 30—A Combination Air Duster and Blower

Baking Out has long been in use by enterprising japanners and consists of running the parts through an oven for about an hour to bring them up to a temperature ranging from 400 degrees F. to 700 degrees F. At this heat the dirt or grease is crystallized and is forced out of the metal itself and, particularly from between assembled parts. After coming out of the oven the parts are gone over with a piece of emery cloth, steel wool or sandpaper to loosen the crystals. These are then removed with either a combination air and bristle duster, a wire cleaning brush (Figure 31) or a cloth.

The above process has also been used in removing old japan from metal, providing the oven used will allow the temperature to go high enough. To assist in this the damper must be closed. By the same method the difficult volatile oils are driven off until there is nothing left but the carbon which may be brushed off. There are great possibilities in the extension of this method.

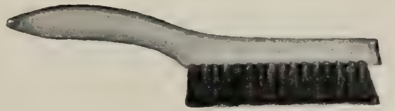


Figure 31—A Wire Cleaning Brush

Die Castings must be given a preliminary heat to drive off the internal gases. The temperature of this heat should not run higher than any of the coats that are to follow, and the duration should be at least one-half hour. This should be followed by sanding off the small round particles that come out on the surface. The japan may then be applied in the regular way.

Zinc becomes brittle at 175 degrees F. and it positively should not be baked nearly as high as that. To remove oil and grease from zinc use carbon tetrachloride and dry immediately.

Aluminum is injured internally when baked at a temperature above 350 degrees F.

Carbon Tetrachloride is the basis of many fire extinguishing solutions sold under various trade names at a big profit. Pure carbon tetrachloride may be purchased for about two dollars per gallon. The material vaporizes at a very low temperature and its fumes extinguish a fire at once. It does not freeze and does no damage to any material of any kind. It is the opinion of the author that great good could be done for the public at large if more publicity were given these facts.

Benzine is the most common and most widely used solution for cleaning metal parts. It is, likewise, the most explosive and the most dangerous, from the standpoint of fire and skin affliction. In spite of these objections it does remove grease and oil. However, it noticeably loses its strength as more and more parts are cleaned in the same solution. There is also considerable loss due to evaporation. A benzine solution should never be used without minimizing the fire risk by adding to it one pint of carbon tetrachloride per gallon.

V. M. P. NAPHTHA (varnish makers' and painters' naphtha), when all things are considered, is the ideal liquid to use. Workmen who work continuously in this or similar hydrocarbons should wear rubber gloves. If gloves are not worn, then the natural oils of the hand that are removed by the naphtha, should be artificially replaced daily by rubbing the hands with specially prepared petrolatum after washing with soap. This will prevent chapping and cracking of the skin. It should be noted here that in the process of refining crude oil the order of distillation of the various grades of hydrocarbons that are made which are similar to benzine is shown in Table 11.

TABLE 11

WEIGHTS OF LIGHT OILS

(15 DEGREES C)

NAME	SPECIFIC GRAVITY	DEGREES BE	DOCTOR TEST	DEGREES C. BOILING POINTS		LBS. PER GAL.	LBS. PER CU. FT.
				INITIAL	MAX.		
High Test Gasoline	.6222	95				5·18	38.89
Gasoline	.6511	85				5·42	40.96
Benzine	·7179	65				5·98	44·87
O. M. P.		57	Sweet	190	330		
Vleum Spirits		47·5	Sweet	290°	430°		
Kerosene	.8000	41	Sweet	350°	540°	6.66	50.00

From the table it will be seen that the evaporation or volatility of the material decreases as the specific gravity increases, so that if care is not used in buying the proper material there is danger of getting a kerosene instead of naphtha.

To remove the oil and grease from aluminum use benzine or V. M. P. naphtha when only a few parts are to be cleaned; but, if a large number are to be cleaned, it is best to use an alkali cleaning solution as described hereafter.

Sulphuric Acid (Commercial) in a diluted form will instantly remove surface rust. Strange as it may seem this acid in its concentrated form will not remove rust. As the solution gets weaker the parts have to be left in longer. The surplus acid must be immediately washed off in a hot-water bath and then, for safety sake, the parts should be plunged into an alkali bath and washed again after that.

The latter operation will neutralize the *eating* effect of any acid not thoroughly removed. The sulphuric solution should never be used until the japanner is ready to immediately coat the parts with japan. Even a wait of 15 minutes will permit the rust to form again. If more than 15 minutes elapses it may be necessary to reclean the parts. The workman should wear rubber gloves and scrub the articles with a *fibre* brush as a bristle brush would be ruined.

Phosphoric Acid forms the base of several patented cleaning methods. One of them is really a plating process but mentioned here for information. Articles are first cleaned by grinding, buffing or sand-blasting. They are then placed in the solution which consists of phosphoric acid and iron, or iron phosphate. The solution is kept at the boiling point and the articles are left in for one and one-half hours. The solution is circulated freely so as to produce a uniform result. The solution is difficult to operate and requires considerable attention and experience. The deposit on the articles is a chalky substance that very readily absorbs oils and japans, either of which must be applied to complete the process, thus rendering them quite impervious to moisture.

A Combination of Phosphoric Acid and Alcohol forms the basis for another kind of patented cleaning compound that removes rust resulting from exposure after pickling or other causes, hand marks, and acid runs. In fact, it is used to prevent rust on steel or sand-blasted surfaces and has been used extensively in automobile factories on steel bodies, and so forth. This material acts to neutralize the acid that causes rust.

The following notes taken from the literature of a manufacturer of this compound will be of interest:

1. In order to produce the proper results it must be properly used. Instructions for its use are very simple and are easily carried out, but, although sim-

ple and easy, they are none the less important and must be followed to secure the full benefit.

2. As it is a metal treating fluid, it must not be placed in metal containers, as it will act on the metal container and lose its strength. Wooden buckets or tanks, earthen-ware cups or enameled ware pails should be employed for holding the material while it is being used. Like all cleaning fluids it is apt to cause the hands to chap. Where the chapping is excessive, rubber gloves should be worn. Petrolatum rubbed well into the pores of the hands also assists in preventing chapping.

3. Do not dilute it as it is supplied ready for use. On large work such as automobile bodies, it should be applied with a brush. Apply generously and do not try to brush out like a paint but flow on like a coat of varnish. Drip pans of aluminum may be used to save the drips. The dripping to the floor may be neutralized and dried up by a sprinkle of powdered lime. It is best to have asphalt floors. Small parts such as fenders, steel stampings, radiator shells, lamp bodies, and so forth, may be wetted by dipping them into a bath. In cases where the parts are prepared by burning off the oil, they may be placed directly into the material without waiting for them to cool. This compound works best when applied at ordinary room temperature.

4. Under usual conditions the cleaning action is automatic; that is, it does all the work itself without the aid of any labor. When the rust is simply "surface rust," it will be completely dissolved in a few minutes. When rust has pitted the surface, the action should be assisted by scrubbing the surface, while it is kept wet using steel shavings, steel wool or emery cloth for the purpose.

5. After the surface has been cleaned it must be washed thoroughly with water when the painting operation closely follows the cleaning operation. Small parts may be dipped into a tank of running water; large work, such as automobile bodies, are best washed with a hose, although a bucket and a sponge is satisfactory. Be sure all cracks and seams are thoroughly washed out. Either hot or cold water may be used. The hot water has the advantage of saving time in drying. The parts should be gone over with a sponge to mechanically remove all loose particles and scum.

6. When hot water has been used for washing the work dries very rapidly. The drying may be done by wiping with dry cloths or a chamois, or by using a jet of steam or compressed air. After the excess moisture has been removed it is necessary to blow out all cracks and seams with a jet of air or steam, and all moisture blown out of the cracks or seams should be removed from the surface of the work by wiping or blowing off. Before the paint is applied the work must be allowed to air-dry. This can be accomplished quickly in an oven heated to 120 degrees F. The time for air-drying depends on whether hot or cold water has been used for washing and on the condition of the atmosphere. The time will range from 15 minutes to several hours. Be sure not to paint the work until it is perfectly dry.

Caustic Soda is one of the most important materials used in japanning. This material is also known as *lye.* In spite of the danger of burning and eating the skin of the worker's hands, it is a most effective remover of baking japan.

There are several different strengths of caustic soda but the correct one for the japanner's use is called *76% solid caustic soda,* which means a certain volume of the material contains 76% sodium hydroxide. This is really 98% pure.

Lower grades are used commercially in small packages for the plumbing and household trade. These are sold as *commercial lye.* Due to taking up moisture and collecting impurities such as iron, in the process of preparation for the market, these lower grades would have strengths of about 72% to 74%, which would correspond to a purity of about 94%.

When caustic soda is manufactured it is poured in liquid form into a drum in which it solidifies. This form is desirable for the large user who consumes the materal in drum lots, since he may cut away the thin outer iron drum and place the entire body in the solution tank in the solid form. From the solid form there is made, for the convenience of the smaller user, the ground and the flake forms. Either of these are satisfactory. The one important point in buying caustic soda for use in cleaning work in the japan shop is to specify *76% caustic soda* and avoid the lower grade forms that are sold as lye.

A cleaning solution tank is needed to maintain the solution at a temperature just below the boiling point in order that the evaporation of the water will not radically change the strength of the solution. This tank should be large enough to take in the largest article that is to be cleaned.

CAUTION

A bottle of weak harmless acid, such as vinegar, should always be on hand to treat caustic burns. An application of this weak acid will neutralize the effect of the caustic at once.

Remover Compounds are marketed by a number of reliable chemical firms and may be used in preference to those mentioned. There are always special applications and difficult problems to overcome which those skilled in the art are able to solve readily.

To Remove Old Japan from metal takes almost one hour of constant agitation and application of heat to the tank, which should be kept just below the boiling point. The agitation can best be secured by placing a pipe, drilled full of holes, in the bottom of the tank and attaching it to a compressed-air supply having the pressure reduced with a pressure regulator so that the solution will not slop over the edges of the tank.

Articles placed in a cold tank at night will have most of the old japan or enamel removed by the following morning. Extra care should be used to see that no metal, other than iron, goes into the tank. You can imagine my surprise one morning when the shop superintendent laid a small handle on my desk saying, "That is all that I am able to find of the automobile hood that came into the shop yesterday." The hood, which was made of aluminum and soluble in solutions of caustic soda or potash, had been placed in the lye tank overnight. The handle was steel.

As lye is an alkali (known by chemists as the direct opposite of an acid) it is important to remove all traces of it thoroughly. This can be done by several washings in water, paying special attention to see that the rinsing water solution is not made alkali itself. However, the easiest and surest way is to neutralize the alkali with some weak acid. Vinegar, being a weak acetic acid and easily obtained as well as being cheap, is usually used.

Chemists use litmus paper, which may be purchased at any drug store, to test acidity and alkalinity. If the solution be acid a piece of blue litmus paper in it will turn red. If the solution be alkali a piece of red litmus in it will turn blue. The shades of red or blue also indicate the degree of strength of the solution. If neutral no change in either the red or the blue litmus paper will take place.

Caustic Potash (also called potassium hydroxide) is an important potassium compound and is included here for convenience. It is, according to the Bureau of Standards, a white deliquescent solid, very soluble in water, and absorbs carbon dioxide from the air. It is one of the strongest bases known. The principal use of caustic potash is in the manufacture of soft soap, shaving soap, toilet preparations, potassium chromate, and many other potassium compounds; oxalic acid, indigo and other dyes and organic compounds; disinfectants, greases and lubricants, in wool scouring, and as a reagent in chemical laboratories.

The largest part of it, probably 80%, is used in soft soaps. Potassium hydroxide is obtained by treating dilute solutions of potassium carbonate with lime at the boiling point. Calcium carbonate settles out and the resulting lye is purified by evaporation and filtration until finally fused potassium hydroxide is obtained. The modern method of preparing caustic potash, which has largely supplanted other methods, consists in the electrolysis of solutions of potassium chloride.

Commercial Cleaning Compounds have come into use very extensively in the last few years. These compounds are widely advertised and marketed under a number of trade names. However, the ingredients contained in these various compounds are not usually disclosed.

The author does not advocate the making of one's own compound, for no one individual japanner can compete in the knowledge of chemistry with a staff of chemists, who are experts. Such a staff is necessary to solve the problems properly and prescribe the formula that will best be suited for certain conditions. The following formula is a typical one:

2 ounces tri-sodium phosphate
8 ounces soap powder
2 ounces caustic soda
1 gallon water

If the work shows a white deposit, upon coming from the rinsing tank, that indicates:

1. The article has not been allowed to stay in the cleaning solution long enough.
2. The article has not been properly rinsed in hot water when it came out of the cleaning tank.
3. The cleaning solution is not up to the required strength.

To get best results the solution must be kept at uniform strength. As an accurate test cannot be made from a boiling solution, dip out enough of the solution to make a test and allow it to cool. An hydrometer when placed in this solution, should read 8 degrees Baumé which indicates an average of one pound of cleaner to the gallon.[1]

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[1] See Chapter XVII for further details.

The best method of cleaning cannot be given, except by someone who has studied and is thoroughly familiar with the problem. Methods and materials used must be suited to meet the different conditions. A cleaning compound of four to eight ounces to the gallon is largely used for cleaning sheet-metal parts, such as fenders, automobile hoods, bodies, horns, boxes, and so on, on which there is grease, stamping compound, oil and such. Any deposit remaining on the work will have no undesirable effect in the later steps of japanning. Nevertheless, in some respects, the same conditions hold here as for the other branches of cleaning.

Different oils on the work sometimes require that other materials be used. A combination of certain chemicals, two to six ounces to each gallon of boiling water, is often best. All parts should always be thoroughly rinsed after the washing. Metal parts will dry of their own heat after a rinsing in hot water. The purpose of the rinse is to remove any dirty water that may be carried out from the wash tank. The cold rinse should be equipped with a surface overflow and the water should be kept running. A hot rinse should be used after this for the purpose of drying the work. After the rinse the seams and corners are blown out with compressed air, and the work is wiped dry with rags. It is then ready to be japanned. By the use of the proper materials and methods the hand wiping may sometimes be eliminated.

THE CHEMICAL ACTION of alkali cleaning compounds was ably explained by Edwin C. Scott, in a paper read before the Connecticut Section of the American Chemical Society:

> The action of alkali in cleansing operations depends upon its well-known property of combining with fatty matters to form soap, and on its direct solvent action on some metals and metallic oxides. The resulting soap has a value of its own in emulsifying mineral oils as a lubricant and a wetting medium. Soap dissociates to a certain extent in water solution, and the alkali thus made available was formerly supposed to have a part in its action. This, however, does not coincide with the fact that, although oleic acid soap dissociates less than stearic acid soap in water solution, it has a good, if not better, cleansing value.
>
> When the oils to be removed are all of a saponifiable nature, or where sufficient quantity is present to produce enough soap to emulsify the unsaponifiable oils present, the alkali alone will be all that is required. In cases where the oils are all unsaponifiable, or very largely so, soap should be used in connection with alkali. This soap may be cheaply obtained by adding some saponifiable oil to the alkaline solu-

tion. Red oil or crude oleic acid is easily obtained at reasonable prices, and produces as good a soap for the purpose as can be obtained.

The alkalies available as cleansers are the carbonates and hydrates of sodium (Na) and potassium (K), and mixtures of carbonates with hydrates. Where a milder action is desired, mixtures of carbonates and bicarbonates, or the so-called sesquicarbonate of soda ($Na_2\ CO_3\ NaH\ CO_3 2H_2\ O$) can be obtained. As cleansers, the salts of sodium (Na) and potassium (K) have about equal values when considered in molecular proportions, from which it follows that one pound of caustic soda (NaOH) will do the work of about 1.4 pounds of caustic potash (KOH). This, together with the higher cost of potassium (K) salts, should eliminate them from consideration, provided, of course, that in practice equal results are obtained.

The particular form of alkali to be used will depend on the substances to be removed, the metal to be cleaned, and the subsequent treatment of the work. In cases where japanning is to be done a preliminary treatment in a hot soda kettle with sodium carbonate is advisable.

In all operations for the removal of oil on work from automatic machines, or where any large amount of oil is present, it is advisable to separate before the work comes to the japanner, as much oil as practicable mechanically, using a centrifugal apparatus. This effects considerable saving in cleaning materials and the oils separated may be clarified and used again.

The soda-kettle method is to agitate the particles to be cleaned in a boiling alkali bath of a strength approximating one-half pound per gallon of sodium carbonate (Na_2CO_3), or its equivalent in other forms of alkali. Small articles are loaded into cylindrical baskets or wire cloth or perforated metal, and either rotated or plunged up and down in the bath.

This should preferably be done mechanically, as a saving in labor is effected, and more uniform results obtained through the elimination of the personal factor. Except in case of finished work, articles cleaned in the soda kettle should not be rinsed, as the alkali left on the work protects it from rust and obviates the necessity of drying.

In the cleaning of aluminum and alloys containing considerable amounts of zinc, lead, tin, aluminum or antimony, it is not advisable to use caustic as these metals are strongly attacked by it. In cleaning steel articles, it is sometimes advisable to use caustic alone, and where unsaponifiable oil has been used, the addition of soap at the rate of one to two ounces per gallon is advisable.

Many prepared cleaners for metal cleansing work are marketed under trade names. In the case of those for oil and grease removal, analysis of a large number has shown them to be composed of mixtures of inorganic alkaline salts. In some cases soap is also used. Many contained more or less inert matter such as clay, calcium, carbonate, sodium sulphate, and so on. Many were sold at abnormally high prices.

> There is another class of soda cleaners, known to the trade as neutral sodas, which are milder in action and especially suitable for laundry work or general cleansing by hand in factories, dairies, hotels, and so forth, and for general household use. These are mixtures of bicarbonate and carbonate of soda in approximately equal molecular proportions, with enough water of crystallization to prevent their caking up on standing. There is also another form where bicarbonate and carbonate are combined chemically and crystallized with two molecules of water known as sesquicarbonate, and having the formula of $Na_2CO_3NaHCO_3 2H_2O$. It possesses the advantages of uniform composition and greater solubility than the mixtures.

A small amount of cleaning compound in the tank will clean better than large amounts of pure mineral cleaners. It emulsifies oils and greases—breaks them up into finely divided particles, thus destroying their adhesive nature. This is purely a physical action.

By a physical action of which little is known the oil is broken up into minute globules. There is no chemical action as there is in saponification. The oil is still oil, but its adhesive nature has been destroyed. The particles of oil are constantly in violent motion in an emulsion.

Sodium Carbonate (also called washing soda) is an effective cleansing agent, not only through its property of softening water but also because of its action on grease. It should be entirely soluble in water and free from caustic alkali. Most of the washing sodas contain sodium bicarbonate in addition to sodium carbonate. This insures freedom from caustic alkali, which cannot exist as such in the presence of sodium carbonate. So-called soda crystals contain over 60% water and when the water is expelled by heating or otherwise the clear crystals disappear and the material becomes an opaque powder with a corresponding increase in strength.

To Clean Galvanized Iron a sodium carbonate treatment is needed. Cleanse the galvanized articles from dirt and grease by immersing in a warm solution consisting of one gallon of water and eight ounces of sodium carbonate. Then wash in cold water and immerse in a warm solution of sal ammoniac and water, using four to eight ounces to each gallon of water. Immerse for a few minutes, until the solution dissolves a small portion of the zinc and leaves a bright surface, then wash and dry by heat. If the surface is badly corroded, instead of the sal ammoniac use four to eight ounces of muriatic acid in the same quantity of water and use warm. A very short immersion in the acid will be sufficient to remove the oxide upon the articles.

Sandpaper plays an important part in preparing the surface and there is much to be learned about this popular but very much misunderstood cleaning department item.

> "Sandpapers and Water-proof Coated Abrasives" is the title of Chapter VII, Volume II, *Practical Automotive Lacquering*. The reader who cares to go deeper into this subject is urged to read this very important information and data.

Many japanners are still using *dry* sandpaper with all its drawbacks and particularly its health hazard while the more progressive individuals have discarded the use of the dry in favor of the waterproof kind. The chapter referred to above contains a very valuable grading table also.

XI

THE SPRAY METHOD OF APPLICATION

Working Conditions
This New Exhausting Idea
A Direct-connected Motor-driven Blower
Advantages of the New Type of Exhaust
The Electric Heater
The Hand-agitated Pressure Tank
Turntables
Special Turntables
The Spray-gun
The Spreader Adjustment
A Suction-type Cup
A Modern Clamping Cup
Gravity-type Spray-guns
The Air Transformer
Material Tanks
Insert Containers
The Air Duster
The Cut-off Valve
The Hose Cleaner
The Modern Spray-booth
The Booth-type Electric Exhaust Fan
The Air Compressor
The Air-storage Tank
To Figure Air Capacity
Combination Power Units
Air-driven Material Agitators
Electric Motors
Leather Belting
Pulley Sizes

Working Conditions in japanning rooms are, as a rule, not the most desirable. With the spraying system installed conditions are greatly improved.

The japan material is heavy, which means that ordinary exhausting systems will not carry the vapor off readily and so it is timely to recommend the new indirect exhaust of the annular type as a late improvement. Here an *induced flow of air* is created through the exhaust pipe connected to the back of the spray-booth.

This is done by blowing a stream of air parallel to the exhaust outlet near its outer end in such a way as to entrain the air taken from the spray-booth proper.

In the early days, an idea similar to this was used, but it involved the use of a small diameter exhaust outlet as a blower type fan creating a *high velocity* of outgoing air.

This New Exhausting Idea requires a short piece of pipe of large diameter for an exhaust outlet and an exhaust fan (Figure 32) which creates a *low velocity* of outgoing air.

The outfit is very flexible and may be installed in difficult places, since the outlet may be located in the top, the side or the back.

A Direct-connected Motor-driven Blower takes air from outside the building and delivers it through a constricted air chamber. This air creates a suction in the exhaust outlet pipe because air flows out evenly through the annular opening between the two almost parallel pipes of slightly different diameters as shown in Figure 33.

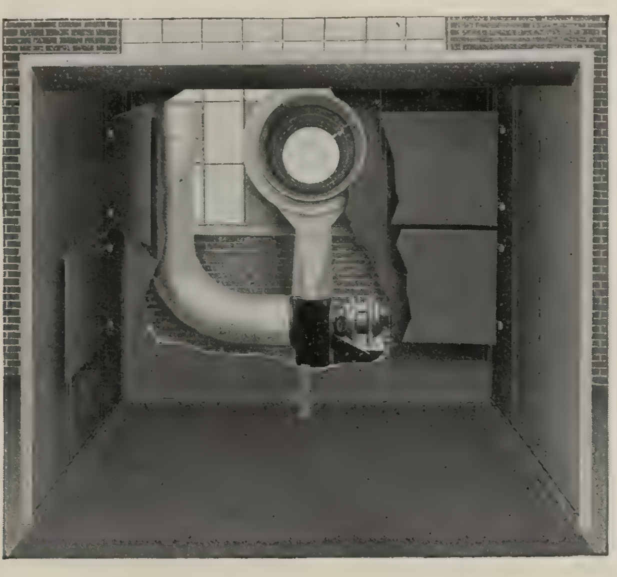

Figure 32—Indirect Annular Type Exhaust (Front View)

Advantages of the New Type of Exhaust may be listed as follows:

1. Produces most efficient exhausting results for power consumed, due to the pressure under which the blower operates.
2. Effective exhaust through the booth proportional to the air delivered by the blower.
3. Low velocity of input air eliminates howl and noise.
4. Nozzle portion of the exhaust unit cannot become clogged and the efficiency of exhaust thereby reduced, as only clean air from outside the booth passes through it.
5. No obstructions of any kind in the exhaust unit or pipe to collect deposits of paint or lacquer. This feature reduces fire hazard to a minimum.
6. More easily and quickly cleaned, due to the large, uniform diameter and short length of exhaust pipe, and absence of obstruction.

7. Simple to install and, because exhaust unit can be attached directly to spray-booth, easily adapted to any local condition or layout.
8. Not necessary to use a vertical outlet pipe when exhausting through side of building. A straight outlet pipe or an elbow will produce most efficient results.
9. Permits the use of one blower for more than one exhaust unit without incurring fire hazard.
10. No adjustments of any kind necessary.
11. Very little air is exhausted from room since blower air is taken from out-of-doors.

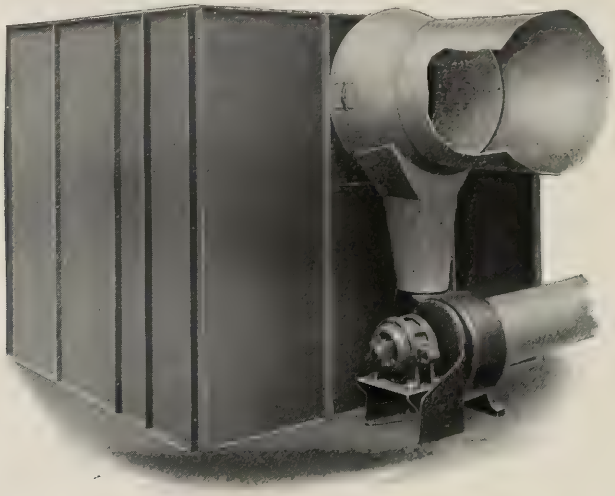

Figure 33—Indirect Annular Type Exhaust (Rear View)

The Electric Heater (continuous type) reduces the amount of volatile thinner used and obtains best results with varnishes and enamels, such as overcoming pebbled or pitted effects.

It has been found that heating both the air and the material (Figure 34) helps very much. The natural cooling tendency of expanding compressed air is thus also overcome. It will be noted that the material is heated *as it is used* and that the heater is mounted on the side of the spray-booth about three feet from the floor.

Both air and fluid pass through the heater, the heat being applied at the nearest possible point to the nozzle so there is a minimum drop in temperature because the shortest possible hose is used.

There is no evaporation of the solvent, cooking or deterioration of the varnish or enamel, such as might be the case, were the fluid container only kept hot. There is little loss of heat by radiation, which means economy in current consumption. The variation in the temperature of the fluid is negligible, whether used fast or slow, as the small amount contained in the heater is quickly heated to the desired point.

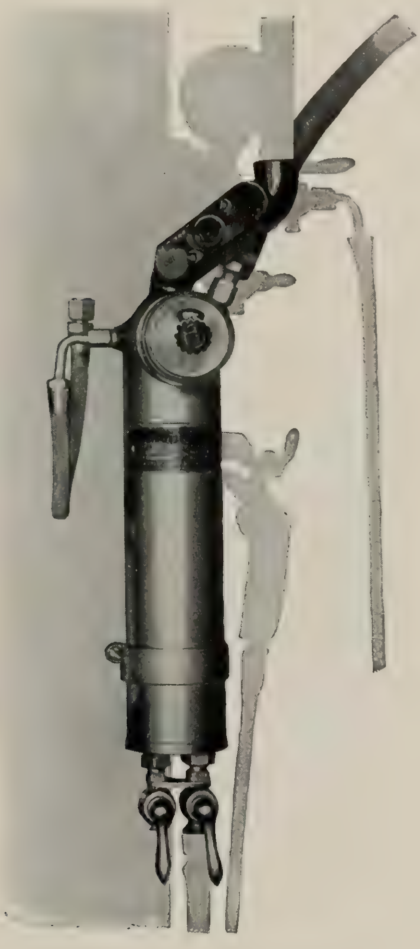

Figure 34—An Electric Heater

One type of heater is equipped with a three-point switch, which enables the operator to meet any variation in the temperature of the finishing room, work or viscosity of the liquid being used. The current consumption is 100 watts on low heat, 120 on medium heat, and 150 on high heat.

Another type of heater is for use where two kinds of varnish are sprayed, or both varnish and enamel alternately, in the same spray-booth. It is provided with two fluid tubes instead of one, in addition to the air tube. Thus two different materials can be used in it without cleaning.

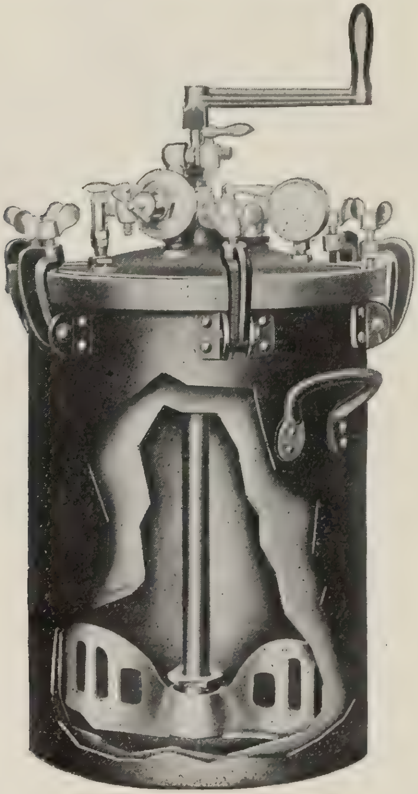

Figure 35—A Hand-agitated Pressure Tank

The Hand-agitated Pressure-tank (Figure 35) is ideal for applying both japans and enamels. As stated herein there is no waste of material where the pressure system is used.

TURNTABLES (Figure 36) are made in various designs and are very important labor savers and cost reducers. How much easier it is to place a part on an almost frictionless fixture and be able to move it at will than it is to laboriously change the part to different positions without such a fixture.

The turntable shown herewith is designed for tilting as well as turning so that the part on it may be placed in a more advantageous position for finishing.

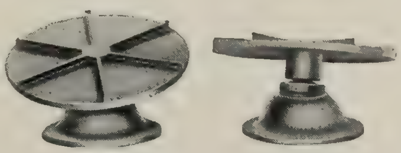

Figure 36—A TURNTABLE

SPECIAL TURNTABLES for special purposes may be built using, for example, motors to turn them, air to lift them, and foot-levers to start and stop them. A little thought given to this device will do much to cut the cost of production and increase the output.

THE SPRAY-GUN (Figure 37) stands first and foremost in the list of tools that one must have to apply lacquer or any finishing material for that matter. It is the hand tool with which the operator directs and controls the flow of materials. It is an atomizer on a large scale and is provided with a nozzle at which the compressed air and material mix. A trigger operated by the finger opens first, the air and then the material valve, the amount of spray being controlled by the pressure applied to this trigger. A material adjusting screw limits the opening.

All types of spray-guns are fitted with several different styles and sizes of nozzles so that any class of surface or material may be handled to the best possible advantage. In this way waste is kept down to the minimum and maximum results are produced. A wide spray suitable for automobile bodies, for example, would not be an economical one on narrow surfaces. Often, it is a mistake to try to use the same type of spray-gun even with different sizes of nozzles on varying classes of work. The nozzle should be so designed that the stream of finishing material through it is entirely surrounded by the escaping compressed air, the idea being to confine the spray as closely as possible and eliminate waste. In this connection, we sometimes hear of an air envelope surrounding the material to keep its mist from flying around, but an envelope is not possible to obtain with the small amount of compressed air that is released and especially when a low pressure is used.

Hundreds of models of spray-guns have been produced during the last 15 years by dozens of manufacturers and just to give an idea of the effort and attention that has been given to produce a spray-gun that meets all conditions satisfactorily the following are some of the specifications that up-to-date models now have to meet:

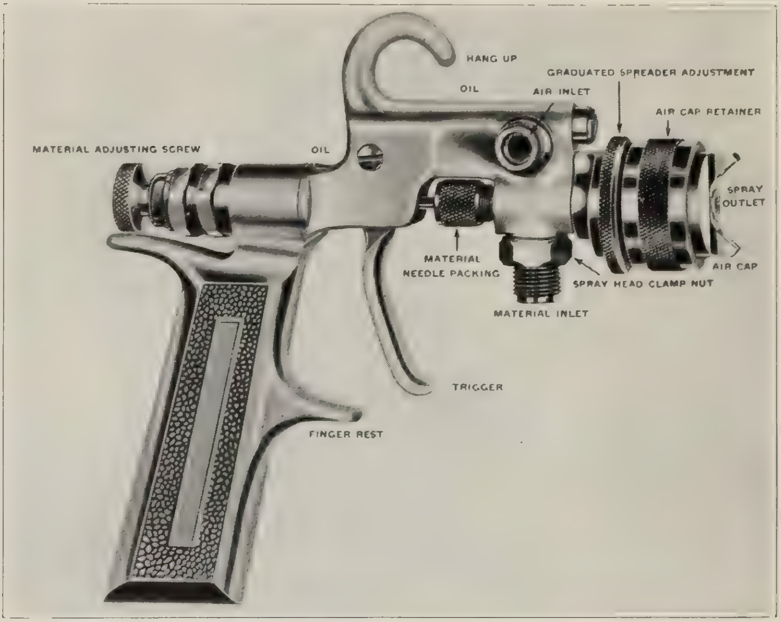

Figure 37.—A Modern Spray-gun

1. The needle adjustment shall obtain accurate and instant control of both air and material when the trigger is pulled.
2. The design shall be simple and have a low number of parts and wearing points. It shall be durable and rugged.
3. All metal moving parts shall be enclosed and protected.
4. The material tip shall be made of hardened alloy steel and accurately ground to gauge.
5. The body shall be of a special high strength, aluminum alloy that is as strong as steel and less than half its weight.

6. Repair or replacement parts shall be interchangeable without interference with continued perfect operation.
7. Both a wide fan-spray with positive and accurate adjustment in any desired position of the revolving air cap and a round, concentrated spray as well shall be produced.
8. The spray-gun shall produce a perfectly atomized, uniform, soft spray under all conditions, with lowest practicable pressures. There must be no *splitting, heavy center* or *overspray.*
9. The nozzle assembly head should contain all parts requiring cleaning.
10. There should be a positive cut-off to insure no dripping of material at end of nozzle.
11. The passage through the bore of the spray-gun should be unobstructed.
12. Material shall come in contact with metal parts only and these shall be as few as possible.
13. The handle design and the balance shall be combined with free trigger action, using either one or two fingers in such a way that non-tiring operation and easy resting in the hand will result.
14. It is desirable to have a spreader adjustment to control the width of spray as well as its shape so that any desired spray may be produced and a proper balance obtained between the amount of material used, the nature of the work and the operating speed.
15. A self-centering arrangement of nozzle parts shall be provided to insure their being held in positive concentricity at all times for the purpose of preventing air leakage and to provide for interchangeability of parts.

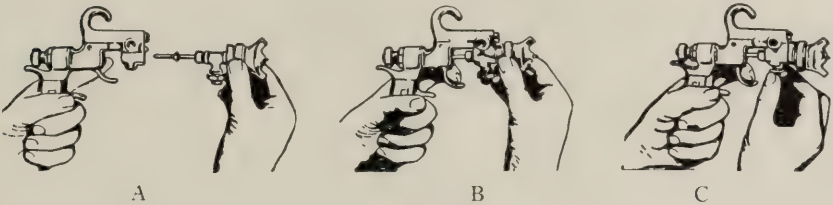

Figure 38—Assembling a Two-part Spray-gun

The two-part assembly feature is a very interesting development (Figure 38). Here A shows the body or mechanical part in one hand, while the parts that come in contact with the finishing material are shown in the other hand; B shows how these two sets of parts are brought together, while C illustrates the method of securing them and thus making the single spray-gun shown in Figure 37.

It is interesting to note that this design makes it possible to change to a different size of nozzle, thus saving the user the expense of purchasing an entirely new spray-gun.

The construction of a spray-gun must be such that, with low air pressure ranging from 40 to 60 pounds and a minimum air consumption, the material is softly, finely, and evenly atomized. When these conditions exist a smooth and uniform coating may be applied. The perfection of atomization and uniformity of coating, of course, reduces sanding and rubbing labor to a minimum. In fact, some of these operations are often eliminated altogether. The proper choice of a spray-gun will give ample speed of operation without sacrificing in any way the high quality of the work that is being done.

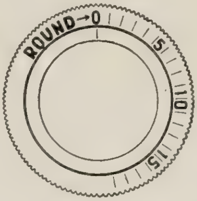

Figure 39—Spreader Adjustment

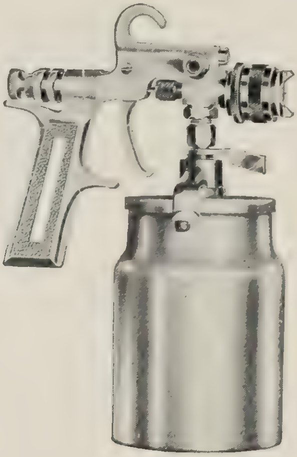

Figure 40—A Modern Suction Spray-gun

THE SPREADER ADJUSTMENT (Figure 39) is marked with graduations. A round spray is obtained when the index line on the side of the spray-gun coincides with the zero graduation. Beyond this position a fan-shaped spray is obtainable commencing with a narrow one and increasing in width until the final graduation is reached. When the desired shape of spray is obtained the air-cap retainer (Figure 37) can be tightened and the spreader adjustment reading noted. Thus a means is provided for a quick return at any time to the same adjustment.

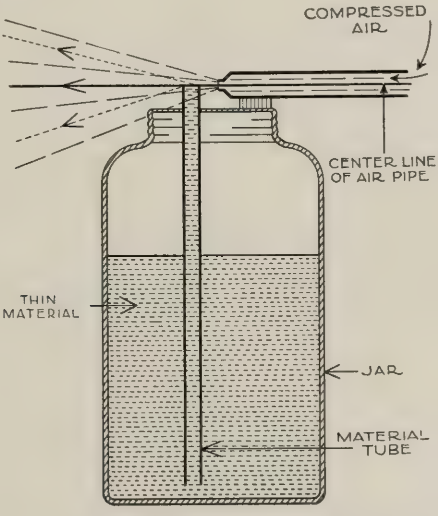

Figure 41—A SUCTION-TYPE SPRAY-GUN IN ACTION

The spreader adjustment controls the air which produces the fan-shaped spray. This is entirely independent of the air used in the adjustment of the amount of material used. (Should the spray split or become thin in the center, the spreader may be adjusted to overcome it.)

A SUCTION-TYPE CUP attached to this spray-gun described above immediately creates a modern suction-type spray (Figure 40), the theory of the operation of which is graphically told in Figure 41.

Here it is seen that the expanding compressed air rushes past the top of the material tube with such force that a vacuum is created, causing the material to rise in the tube and mix with the compressed air. This is a very crude and very inefficient design as regards waste of both compressed air and material, but it is the basis of the design of all suction spray-guns. Modern types confine the compressed air and direct its escape from the nozzle assembly in such a way as to surround the material as it passes through another small opening in the center of the nozzle proper.

Where relatively small quantities of material in several colors are used the suction-cup is invaluable. Color or material changes are easily made by the use of additional interchangeable cups some of which may be had with an air-tight spring-clamp cover if desired.

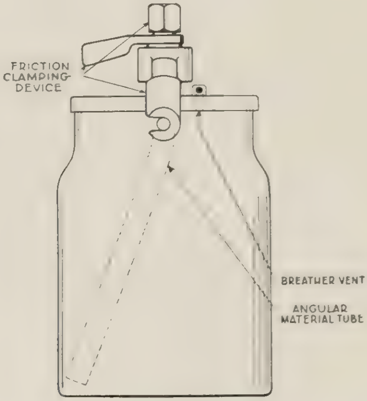

Figure 42 A MODERN CLAMPING CUP

A MODERN CLAMPING CUP (Figure 42) of the suction type has a large opening for easy cleaning. The rigid lid is fitted with a leather gasket cemented in place. With this lid firmly clamped on top of the cup by the clamping yoke—and with the material tube of continuous length, there is no leakage. An ingenious friction clamping lever tightens the cup in any position.

In order that the spray-gun may operate, an inconspicuous but very necessary hole called the breather vent is placed in the lid. Free air is admitted to the cup through this hole to balance that taken out of the cup by the suction action of the spray-gun in operation. Also, when the cup tilts all of the material in it may be removed through the angular material tube.

Gravity-type Spray-guns (Figure 43) have served their time and will be nearly all replaced by the pressure type. They are closely related to the latter anyway, since they take their material from an overhead container which gets its head (pressure on the material) from gravity due to the vertical height of the column of paint represented by the distance between a line drawn through the nozzle of the spray-gun and one drawn through the surface of the material in the overhead container. When the container is raised

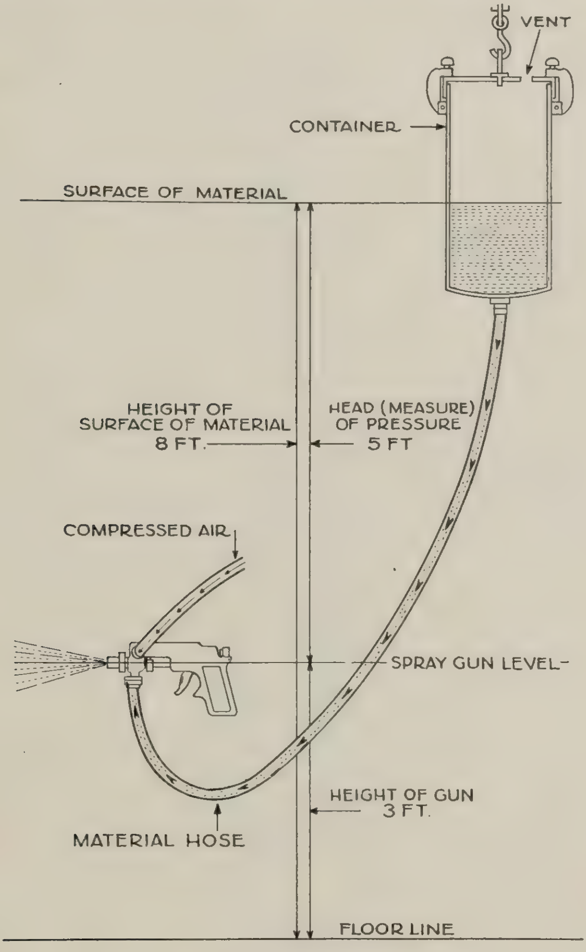

Figure 43—A Gravity-type Hook-up

above the spray-gun, gravity causes the material to flow. The same spray-gun that is used in the gravity method is used in the pressure method described below.

The Air Transformer (Figure 44) serves a most valuable purpose, for it traps the oil, waste, and dirt that are always found in the air-line and must be removed to prevent defects in the work that is being done. This device not only eliminates all moisture, oil and other foreign matter from the air used, but it provides a means for indicating and regulating the material-atomizing air used at the nozzle. Two spray-guns may be connected to a single transformer, for example, one for undercoats and the other for lacquer.

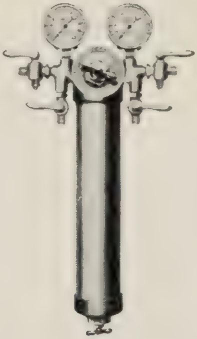

Figure 44—The Air Transformer

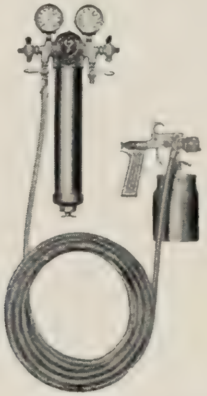

Figure 45—The Simplest Spraying Outfit

A large condenser tube is provided and equipped with a series of baffles through which the air passes. These baffles collect the oil and moisture which are then drained out by means of the valve at the bottom. Thus, the purifying operation is practically automatic. One gauge is used to indicate the main line air pressure, and the other the regulated air pressure.

By attaching a suction-feed spray-gun (Figure 40) to one of the two cocks on the left of the air transformer (Figure 44) the simplest outfit (Figure 45) is ready for use.

Material Tanks (pressure type) (Figure 46) are used where the production is greater. Usually a tank of two-gallon capacity is used in small japanning job shops.

This type is almost essential where it is necessary to turn the spray-gun at difficult angles to more effectively handle the work.

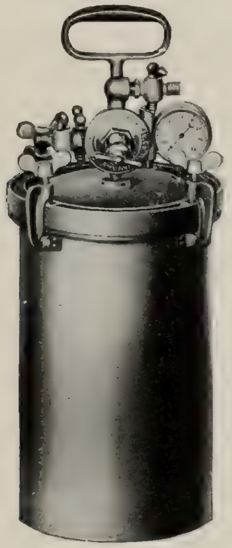

Figure 46—A Pressure-type Material Tank

The flow of material is easily adjustable and is fed to the nozzle of the gun more uniformly and in greater volume than with any other method.

The tank is made of steel, has a welded bottom and is heavily plated inside—a very important detail to prevent rust and other forms of corrosion. On the cover are mounted an air regulator, pressure gauge, safety valve, relief valve, air and material cut-off valve, as well as the material outlet tube. The straight sides of the tank and the opening of its full diameter when the clamped top is removed, make cleaning easy and make practicable the use of full-sized insert or extra material containers where necessary to make frequent changes in colors. The material tank shown here has a *spade* handle with which it may be easily and comfortably carried.

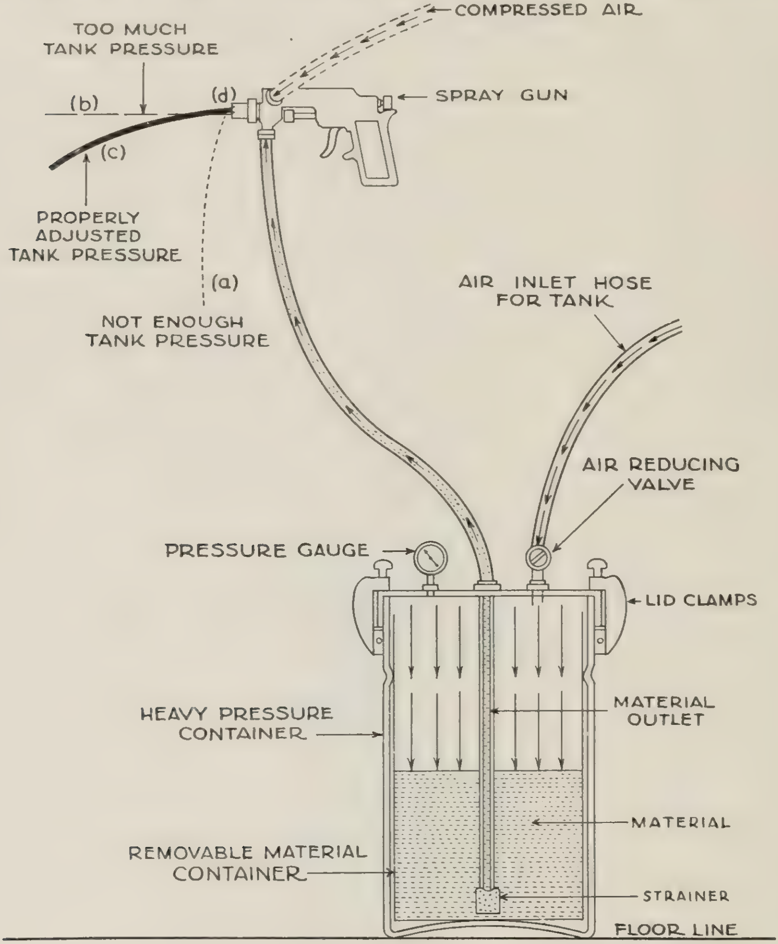

Figure 47—Adjusting the Material Flow in a Pressure Hook-up

The pressure-type material tank is the practical type for the japanner to use on account of the heavy gravity of the materials used. In almost every case where continuous production is maintained, pressure-feed equipment provides the most practicable and economical method of serving material to the nozzle of the spray-gun.

The flow of material is easily adjustable (Figure 47), is more positive, may be kept more uniform, and may be applied in greater volume than with any other method. Less air pressure is required at the nozzle of the machine to obtain speed of operation. Waste is eliminated and vapor is reduced to the minimum.

The pressure-type container is similar to the gravity-type except that instead of the dependence upon the height that the container stands from the floor to furnish the correct pressure this feature is placed in absolute control of the operator, who has only *to turn a valve* in order to meet accurately any change in gravity, weight or viscosity of the material that is being sprayed. This flow *of material* may be adjusted, *while the atomizing air is disconnected or shut-off,* so that the material only comes out of the end (d) of the spray-gun. If the material *shoots* (b) across the room, that is an indication of too much pressure. On the other hand, if it *drips* (a) that indicates not enough pressure, while the ideal adjustment (c) is a slow, smooth flowing stream of material that is a happy medium between the two extremes just mentioned.

INSERT CONTAINERS for material tanks provide a very nice method for the japanner to use. They fit inside the pressure-type material tank, which makes frequent changes practicable and allows economical use of small quantities of lacquers or other materials. Also, they simplify cleaning. Additional insert containers with covers can be kept on hand already filled with the standard materials.

The use of an insert container of almost any size or shape is made possible by the principle of operation of the pressure container which consists of inserting a material outlet pipe in the material (Figure 47) and then providing air pressure on top of the surface of the material to force it first downward and then upward through the material tube. This causes the material to seek an outlet through the tank outlet pipe, the other end of which is connected to the flexible material hose.

This type of material tank, made with a heavy outer casing and a wide open top permits of the insertion of an extra or insert container or in other words, an inner pail with a handle on it. This means that the outer tank does not have to be cleaned, it being necessary only to lift out the *inner pail.*

A size of pressure feed tank is made that is large enough to take in a whole regular five-gallon square shipping container just as it is shipped from the material manufacturer. This may be set inside the outer tank, the cork or cover removed and the outlet pipe (attached to the top section of the pressure tank) inserted directly through a hole cut in the square five-gallon can! This means that the varnish or lacquer material is *never exposed* from the time it leaves the manufacturer's storage tanks until it goes on the work.

THE AIR DUSTER (Figure 48) is a valuable addition to any spray outfit since it is used to remove loose dust and dirt from the work.

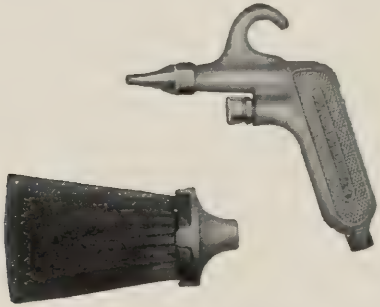

Figure 48—THE AIR DUSTER

It is also useful for cleaning out motors and for other cleaning operations such as blowing shavings off machinery, chips from jigs and tools and for testing. *It should be noted that while a slight pulling back of the trigger on the spray-gun will provide a light flow of air for dusting, this idea is not practicable as the volume of air thus obtained is too small to produce satisfactory dusting.*

This duster may be attached to a valve of the transformer (Figure 44) where it will receive, after passing through the filter, air free from oil and moisture. The nozzle of one make of air duster has an opening 3/32 inch in diameter as compared to the very small air opening area equal to about 1/16 inch in diameter in the ordinary spray-gun. The special bristle attachment is of advantage where dust from sandpapering is to be removed, for example. It may be attached in place of the regular air-dusting nozzle cap and thus provides a combination dusting and blowing device.

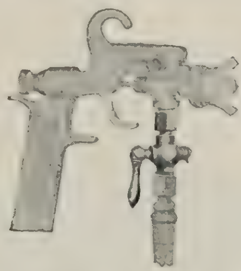

Figure 49—The Cut-off Valve

The Cut-off Valve (Figure 49) seemingly is not important until one desires, for some reason or other, to remove the spray-gun.

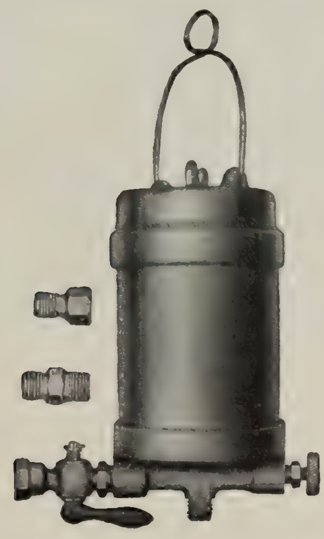

Figure 50—The Hose Cleaner

Then it becomes especially valuable as it is not necessary to disturb the regulation of the entire hook-up.

The Hose Cleaner (Figure 50) provides for keeping the material hose clean. It operates by forcing a spray of solvent through the hose, thereby thoroughly removing all finishing material from within. Its use insures highest quality spray results and lengthens the life of the hose. Extra fittings are included to accommodate various hose connections.

The Modern Spray-booth[1] (Figure 51) is designed to give the utmost in exhausting efficiency where a greater volume of work is done. In these spray-booths there are design features that are worthy of note, especially when an attempt is being made to decide which types to install. These design features incorporate the following:

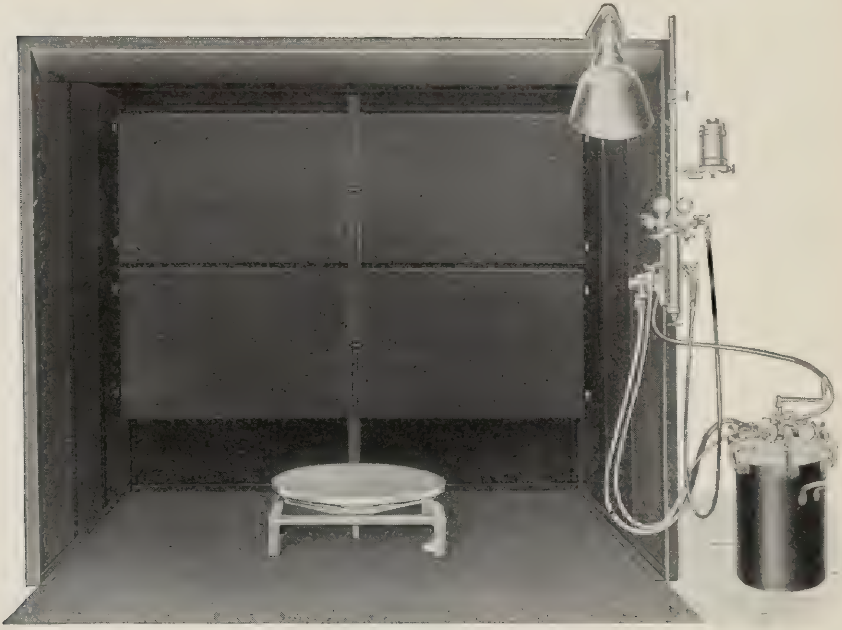

Figure 51—A Modern Spray-booth

1. Exhausting may be done from back (Figure 52), top or either side.
2. Shortest possible outlet pipes should be used so that funnel-shaped backs and elbows will be eliminated.
3. Distributing plates spread the exhaust uniformly over the entire cross-section of the booth and cause an even and positive air current to flow toward the exhaust fan.
4. These distributing plates collect most of the waste matter which makes the spray-booth easy to clean.

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[1] Compare this with Figure 32, page 93.

5. Deeper working space is provided by an especially designed and constructed exhaust fan and motor (Figure 54), which may be located at any point.
6. All-metal construction is provided, including apron for sprinkler use to direct the sprinkler flow toward the flame in case of a fire in the spray-booth.

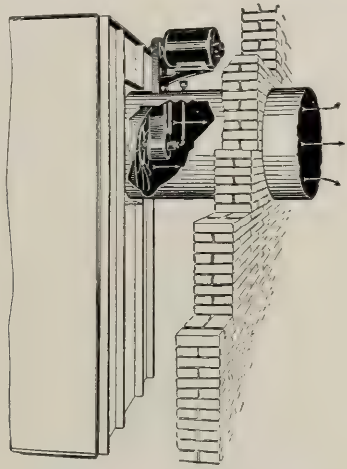

Figure 52—Perspective View of Spray-booth with Back Outlet

7. Sprinkler heads are installed thus reducing installation expense.
8. All fire underwriters' requirements and legal regulations are met.
9. This type of exhaust may be adapted to any available space and it is easy to install.

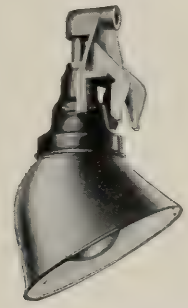

Figure 53—A Vapor-proof Lighting Reflector

10. It requires less power to operate.
11. It costs less to install than older designs of spray-booths.
12. To meet special conditions, booths may be furnished *without* backs and distributing plates. For example, the exhaust fan mounting may be made in

a window or even through a wall opening in bot
may be omitted.

13. Lighting is accomplished with vapor-proof reflec
conduit and attached along the sides of the booth
so as to focus the light on any portion of the worl

14. Sheet-metal floors extending four feet in front of
especially when floor of finishing room is made

THE BOOTH-TYPE ELECTRIC EXHAUST
mounted outside the spray-booth. It meets f
lations by eliminating the necessity of dra
motor, as is done when the motor is connect
located within the exhaust outlet. Where it

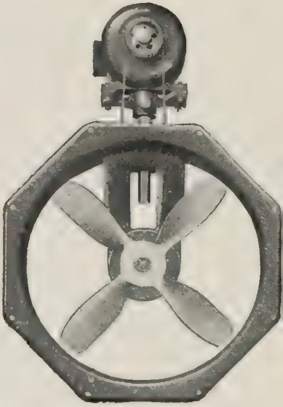

Figure 54—BOOTH-TYPE ELECTRIC EXH

air to remove the vapor only is drawn out o
a more even temperature and cleaner work.

The fan used for automobile spraying is

For occasional refinishing work or where one gun is use
a smaller capacity air-cooled air compressor (Figure
used. For average operating conditions a 4½ inch x 4
cooled compressor may be used successfully.

Where the largest production is handled with spray-b
ment, a 4½ inch x 4½ inch water-cooled air compresso
air capacity large enough to operate three spray-guns, is
ommended. These compressors are of the vertical, sir
type. A cast-iron base is furnished with each compresso
ings are die cast. Lubrication is of the automatic splash

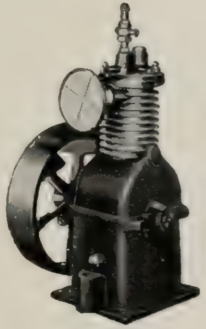

Figure 55—An Air-cooled Air Compressor

compressor should be equipped with an adjustable auton
unloader, which constantly maintains any desired air-ta

In the future, compressors will have to be built along
ent lines from those that have been produced in the p
history of the development of air compressors there h
more exacting demand than its use in connection with pa
and lacquer spraying because these finishing materials

low point—usually five to ten pounds under the point mentioned above, the unloader mechanism acts to admit air to the compression chamber. As the motor is already turning the operating parts there is no danger of stalling as a result of trying to start the compressor against whatever pressure there is in the air tank. Of course, when the plant is originally started with no air in the storage tank there is nothing to worry about because the outfit starts from zero air pressure and proceeds to fill the tank until the unloader acts. After that point is reached it is a continuous performance of start and stop all day. To the eye of the observer, however, this is not apparent.

Considerable thought and attention should be given to the installation of the air piping so that all moisture possible will be drained out before it passes through the piping system and overtaxes the transformer set, the function of which is to take out the excess moisture that is not otherwise taken out by proper draining and trapping. All reliable spray equipment manufacturers give their customers specific instruction on how to do this.

A common mistake in installing piping for spraying purposes is to choose a size of pipe that is too small. There is really no objection to making it too large if the cost is overlooked. It is a good idea to start at the compressor and use the largest size pipe that the particular compressor will allow and to continue with that size as far as possible before reducing it to fit the spray-booth connections.

Some of the requirements that are important in the design of air compressors to be used for paint, varnish, lacquer and japan spraying may be listed as follows:

1. Valves should be made of a non-rusting steel.
2. Heads should be removable so that the valves may be serviced without disturbing the gasket or piping.
3. Closer attention should be given to increasing the efficiency of the entire machine—for example, decreasing the friction in the intake and discharge pipes.
4. Capitalizing on the experience of those automobile manufacturers who have by hard knocks learned the importance of such things as grinding cylinders to closer limits; making pistons lighter; manufacturing the crank-shaft to close limits and so on will be found profitable.
5. Extending the use of roller and ball bearings to support the crank-shaft.
6. A closer study of the parts that have to be repaired or replaced so that they may be made more accessible.
7. Increasing the speeds used which will result in the use of a smaller compressor for a given capacity as well as an increase in operating efficiency.

8. Improving the oiling so as to prevent anything but compressed air from entering the piping system. This point is exceedingly important.
9. A broader use of the idea of cooling the cylinders of air-cooled compressors as well as by more effective general design so that there will be no need for water-cooled compressors in finishing rooms. Naturally, this will reduce the installation and the maintainance expense.

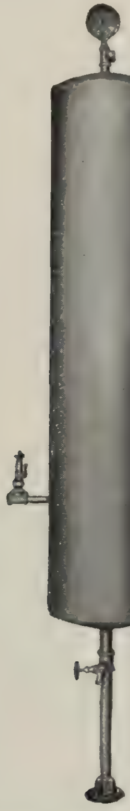

Figure 56—THE AIR TANK

THE AIR-STORAGE TANK (Figure 56) furnishes air-storage capacity, usually 30 gallons, to allow a temporary consumption of air in excess of the compressor capacity. The air receiver is equipped with a pressure gauge, adjustable pop safety valve, and drain valve.

Welded tanks are extremely satisfactory for this, but some localities—particularly large cities, require a heavy, riveted type which, of course, must be used, if the local authorities demand it.

To Figure Air Capacity of a compressor it is necessary to know the following:

D—Diameter of piston in inches
S—Length of stroke in inches
R—Revolutions per minute of compressor
C—Number of cylinders in the compressor

The average efficiency of compressors is about 60% so by substituting the *figures* representing the above *letters* in the following formula we will arrive at the volume of air or displacement in cubic feet per minute which we will represent by the letter V. Thus:

$V = .0002796 \times D \times D \times S \times R \times C.$

As an example, to determine the air that a small compressor that is being operated by a one-horsepower motor will supply, substitute its measurements in the above formula as follows:

$V = .0002796 \times 3 \times 3 \times 4 \times 500 \times 1$
$V = 5.03$ cu. ft. per min. for a compressor that is 60% efficient.

A study of this will show that in using compressed air for spraying purposes, *volume* is the big factor and to get it we must have *horsepower*. This explains why a compressor operated by a ½-horsepower motor that is capable of creating a pressure of 200 pounds for pumping up tires will not serve for lacquer or painting

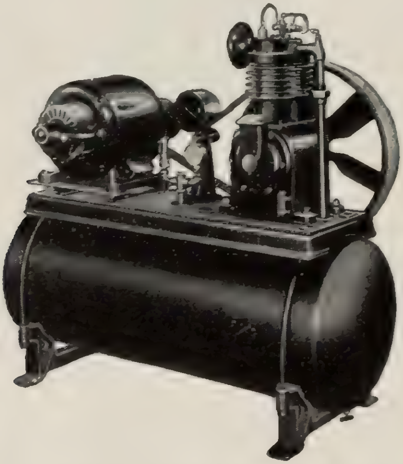

Figure 57—A Combination Air Compressor and Air Tank

purposes, since the average consumption of a spray-gun is 5 cubic feet of air per minute.

Combination Power Units (Figure 57) are available for those desiring a compact and complete unit consisting of the compressor, electric motor, and the air receiver grouped for placing in a small space. An air transformer can be mounted on this outfit also. The electric wiring is all that users need furnish. Thus, the installation expense is greatly reduced—a point often overlooked in buying compressors for spraying use.

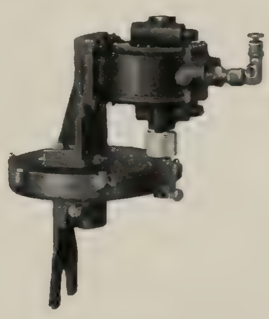

Figure 58—An Air-driven Material Agitator

Air-driven Material Agitators (Figure 58) are playing an important part in production work. They are installed on material tanks larger than those described. They are equipped with a specially designed reduced gear device that may be air operated continuously or intermittently as desired. Where a material that is likely to settle is in use this device becomes very valuable for uniform and uninterrupted spraying. Contrary to the usual understanding, there are few materials in the market that do not settle out at least partially and especially when they are thinned. Therefore a device of this kind fills a real need. Agitators are also available for operation by a hand crank.

Electric Motors are furnished in two types—alternating current and direct current and usually in either 110 volts or 220 volts. In the case of alternating current motors, it is well to install one of large size to operate the air compressor since the power consumption is figured according to the amount of current used, regardless of the size of the motor.

However, in the case of direct current motors, one should be a little careful in selecting just the right size, since a larger motor than that needed will consume more current and make the power bill larger. This is not true of alternating current motors.

LEATHER BELTING is much used for driving air compressors. The farther the shaft centers are apart, the better the arc of contact—10 to 15 feet is not too much. The slack side of the belt should be on top.

The belt should ride in the center of the pulley and should not be any tighter than is necessary to drive the compressor without slipping. It should be from ½ inch to 1 inch narrower than the face of the belt wheel.

PULLEY SIZES may be easily selected by noting the following information:

RPM = Revolutions per minute
HP = Horsepower

To find the proper size pulley for any given speed, use the formula:

$$A \times B = C \times D$$

Let A = the speed in revolutions per minute of the motor or the driver shafting
B = diameter in inches of the pulley on the motor or the driver
C = diameter in inches of pulley on the compressor or shafting to be driven
D = speed in revolutions per minute of the compressor or the shafting that is to be driven.

For example, it is desired to operate a compressor at a speed of 650 r.p.m. The compressor has on it a pulley 12 inches in diameter. The electric motor runs at 1,750 r.p.m. and it is desired to find the size of the pulley to put on the motor to give the proper compressor speed:

$A = 1750$ $B = ?$ $C = 12$ $D = 650$

Therefore,

$$B = \frac{12 \text{ x } 650}{1750} \text{ or } \frac{7800}{1750} \text{ or } 4.4''$$

This indicates that a pulley 4.4 inch in diameter should be used to get an exact speed of 650 r.p.m. on the machine, but pulleys are made standard only in half-inch sizes, such as 3½ inch, 4 inch, 4½ inch, 5 inch, and so forth. This makes it necessary to use the nearest standard size to what is needed, which in this case would be 4½ inch.

When it is essential to be absolutely certain about the speed of any machine, it is best to check it with a speed indicator rather than to trust calculation.

XII

OTHER APPLICATION METHODS

Automatic Japanning
Brushing
Care of Brushes
Brushes
Centrifugal Coating
Cupping
Dipping
Steel Coil Springs
Temperature and Cleanliness
The Solvent Process
The Order of Application
Machine Dipping
The Floco Process
Printing
Hand Rolling
Machine Coating
Tumbling

Automatic Japanning of small parts is entirely new, several patents having been applied for. In the process small parts such as screws, rivets, nuts, glove and skirt fasteners, shoe buttons, eyelets, and so on, are fed into the top of a hopper. They come out of the hopper onto a slow-moving conveyor which carries them through the oven and finally into the shipping container. Not a hand touches them from the time the parts are placed in the hopper until they are dumped into the shipping container. The low cost of production, quality of work produced, and the small space occupied by the japanning machine are very surprising indeed.

This method will replace the tumbling method where there is enough production.

Brushing need hardly be mentioned now since over 95% of the japanning is done by the spraying and dipping processes. Because of the heavy gravity of japan and of the "gluey" property it has, the brushing of this material is the most difficult of any of the materials that are applied with a brush. Brush-hands who are accustomed to applying varnish, for example, make a complete failure of brushing japan. Of course, there are brush-hands who excessively reduce their japan with benzine, or turpentine, and who not only obtain a poor gloss on their work, after it is baked, but who apply a finish that will not last as long as it would had it been properly applied.

It will usually be found that successful japan brush-hands are very temperamental. They must have the combined qualities of clean living, patience, deliberation, care and accuracy. I never met but two real japan brush-hands. One of them talked but very little and when he did it was in monosyllables. He would be late to work in the morning and would quit early at night and if the foreman said a cross word to him he would quit at once. Yet he would turn out more brush work daily, than any two ordinary brush-hands. The other worked at the bench all his life and never knew any other trade. Until he was about 45 years of age, he never was absent from work to exceed a total of more than 10 days. He was the author's foreman for many years, and always persisted in doing *all* the brushing himself. Truly he had not an equal for speed and quality. Therefore, whatever information the author is able to give to the reader on the subject of brushing should be credited to Frank Ruczika.

The brushing of japan is quite different from ordinary brushing. The coat of japan is applied with a uniform even stroke *across* the surface with the brush tilted at an angle of about 30 degrees in the direction in which it is moved. Skill will have to be acquired in taking just enough material on the brush to enable the operator to make a complete stroke without doubling back. The strokes are much shorter than those used by a varnish operator. After the entire surface has been coated lengthwise then the coating should be worked out by drawing the brush crosswise in the same manner *without* taking more material on the brush.

After applying the first coat it is customary to rub it down by using fine pumice stone in water after which it is dried and polished with a clean chamois-skin.[1] Therefore, the chamois-skin is an important article in the japan brush-hand's tool kit. (Chamois should never be washed in water hotter than lukewarm, and should be thoroughly rinsed to remove all grit.)

CARE OF BRUSHES is more important in japanning than in any other class of coating. Brushes for japanning should never be placed in linseed oil when not in use and should *never* be washed in turpentine, because there is so little turpentine used in the material itself that the use of a turpentine-washed brush would tend to thin out the material in which it is used. The best preservative is a finishing varnish with the drier omitted. There are on the market a number of good specialties for the purpose of preserving brushes.

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[1] See Volume II, page 179, *Practical Automotive Lacquering*, for further information.

Brushes when not in use should always be kept as clean as possible and the bristles straight and compact. They should never be kept in water. Bristles will not swallow-tail or separate if the brushes are kept clean. The brush should not be allowed to stand on its bristles, but should be suspended. A simple way to do this is to drill a small hole in the middle of the handle of the brush through which a piece of straight wire or a hook may be passed to hold the brush in suspension. Brushes which are not to be used for some time should be *worked clean* on a board and soaked for a short time in benzine, before washing out with soap and water. Each brush should then be wrapped separately in paper and laid away.

BRUSHES used in japanning are exceedingly important. It goes without saying that the surface to be brushed must be thoroughly cleaned and free from dust and grit; therefore, it follows that the first tool that a successful japan brush-hand should have in habitual use, to insure a clean surface, is a long-handle round duster with a good grade of long camel's-hair bristles.[2] The long handle helps in giving a sort of swinging stroke on the surface to be cleaned. The camel's-hair will not scratch. Another very important tool is a high-grade, sharp edge, spring-steel putty knife[3] for use in forcing putty into any holes or scratches that may be in the surface. The best brush for applying japan is known as a chisel, double-thick fitch (Figure 59). It comes in different widths. A two-inch width would be proper for ordinary work.

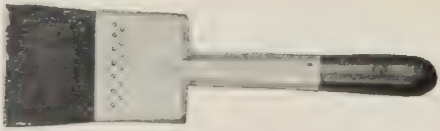

Figure 59—CHISEL FITCH FLOWING BRUSH

Brushes may be identified in a general way from Table 12.

Flowing brushes may be had in from one-inch to three-inch width cement set. Some brushes are made of a mixture of different kinds of bristles.

CENTRIFUGAL COATING has also been used to apply japan but to a limited extent. This is really a special application of the dip. The work is first dipped into a circular tank of japan by means of a mechanical or hydraulic lift, after which it is raised and revolved at high speed, the object being to throw off the surplus material by centrifugal tendency. This is the same principle as that used in a cream separator. The surplus material is drained back into the original container. After the wheel has revolved sufficient revolutions in one direction a lever is swung over to the other side causing the wheel to revolve in the opposite direction. Any excess of material that was not thrown off during the first series of revolutions is thrown off during the second.

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[2] See Figure 29, page 79.

[3] See *Practical Automotive Lacquering*, Volume II, Chapter V.

TABLE 12

BRUSHES

KIND OF HAIR	ANIMAL	COLOR OF BRISTLE	USUAL USE
Ox (Inside of Ear)	Ox		Fine Japanning and Enameling
Siberian	Ox		Coloring
Chinese	Swine or Hog	Black	Furniture and Automobile Finishing
Skunk	Skunk		Furniture Finishing
Fitch	Squirrel		Furniture Finishing and Flowing
Camel's	Siberian Squirrel	Blue	Japanning and Automobile Finishing
Camel's	Russian Squirrel	Red	Japanning and Automobile Finishing
Camel's	French Squirrel	Gray	Japanning and Automobile Finishing
Polar Bear	Polar Bear		Flowing
Russian	Badger	Gray and White	Flowing and Automobile Finishing
Civet Cat	Bear	Black	
French Bristle	Skunk	White	
Red Sable	Sable	Red	

The process is used to some extent in applying paint to automobile wheels. As soon as the wheel is drained it is thrown off into a slot which guides it by gravity, through the oven and finally to the assembly line.

The same idea is also worked out with a wire basket. Articles of various shapes and sizes may be placed in the basket, without regard to the form or relative position; that is, they may substantially be dumped into the basket which is then covered by a flat sheet-metal cover. To prevent the articles, which pile up against the cover near its circumference during the rapid rotation of the basket, from becoming marked or blemished by having some portion resting against the flat surface of the cover plate, a lining of wire mesh for the underside of the cover is provided. When the articles are placed in the basket and the cover secured in position, they are immersed in the coating liquid. This immersion is only momentary, as immediately after the basket is rotated to throw off the superfluous liquid coating from the articles and spread the remaining coating thinly and evenly. After this spinning of the basket it is removed from the arms and taken to the baking oven, where the articles are baked while still in the basket.

CUPPING is a rather interesting and novel method of applying coatings—particularly lacquer. It has the advantage of saving on labor and material. The parts to be coated are first suspended from a rod or rack leaving the space below free. The coating material is placed in a cup and *this cup is raised up* in such a way as to immerse each article or group of articles. It is than immediately lowered and the operation repeated on the next article or group. The method might be defined as the *reverse* of dipping.

DIPPING parts in japan and enamel is the cheapest and the method most used. By this method the articles are lowered into a tank of the finishing material, thoroughly covered and then pulled out and allowed first to drain and then to dry. The best example of a large piece of work that is finished by dipping is farm wagon boxes. However, there are many small metal articles that are now *painted* by the slow brush method. These could be dipped and baked at a lower cost. This would mean a cleaner, better, smoother and a more durable finish at lower cost.

Hand dipping of articles in *heavy* material consists of first suspending them from suitable racks, rods or hooks and then immersing them in the desired material which has been reduced with a specified solvent to a consistency which will leave a smooth, even coating of paint upon the parts after the excess has been completely drained from them. They are then removed and placed upon the drip rack in order that the paint may be more completely drained off; or gradually advanced by a suitable conveyor to make room for other parts which are to follow. When the japan has completely drained off, the racks or rods, from which they are suspended, are removed from the dip rack and placed upon trucks, or suitable supports, for drying and baking. If it be desired to remove all traces of dripping the parts are gently stroked wherever necessary with a suitable brush, moistened in turpentine, after the excess of material has drained off.

In hand dipping parts in *thin* material they are first suspended from suitable racks, rods or hooks and immersed in the desired material which has been reduced as described. They are then removed with an uninterrupted motion and allowed to drain into the tanks for a few seconds, or until the material flows from them drop by drop, after which they are placed upon suitable supports for drying or baking.

The drain board on the dip tank is tilted so as to allow the japan to drain into a separate kettle from which it is strained back into the original dipping tank. Care should be taken that no portion of the work is in such a position that the japan will drain off unevenly. *There should be a downward flow on all surfaces.* The articles are usually hung on a diagonal to accomplish this.

Steel Coil Springs present a problem. They are usually made of cold drawn wire which has an extremely hard and non-porous surface. As the wire is generally of small diameter any coating material tends to run quickly to the underside. The springs are usually dipped and after baking it is found that the under half of the spring is well coated, while the upper half is practically bare. To overcome this, hook from 10 to 20 springs one above the other on a wire or string and then dip. By this method the excess japan from the upper springs runs on to the next below. The one drawback is the time required to string the springs together.

Some japanners place the springs in a wire basket, dipping the entire basket into the japan, then withdrawing it and letting it drain. The springs are then baked just as they are in the basket. The japan should be uniformly distributed over the springs and should not show any contact marks.

The material used is two parts of japan to one part of benzine. It has been found that if the japan be thinned considerably, that is, about one part japan to four or five parts of benzine, a very thin coating is obtained, with which, if baked at a temperature of about 400 degrees F., a uniform covering over the entire surface is obtained. A second coat of one part of japan and two parts of benzine gives a very good finish.

Owing to the very hard surface of spring wire, it is found that the japan, such as is used on cast iron and heavy sheet-metal work, is not satisfactory because, when baked, it will chip off. Thus this hard surface requires specially prepared japan which will admit of the springs being packed and shipped without any protective wrapping.

TEMPERATURE AND CLEANLINESS are of great importance. Metal parts should never be worked on until they are at least up to room temperature. Bringing cold metal parts into a warm japanning room causes condensation on the raw metal, which, if not protected by an anti-rust compound, will often produce an almost invisible film of rust. This will, of course, act as a barrier between the metal and the japan and in time will cause them to separate.

Extreme care must be taken to see that the parts are free from dust, grease or dirt of any kind at the time of coating and also that no dust or dirt is allowed to collect upon them while the material is still wet. All fixtures, rods, holders, and so forth, must be kept clean to prevent smearing.

Before applying a second coat of enamel or japan, the parts should be inspected and if there are found to be any irregularities upon the surface too large to be covered by the second coat they should be rubbed down with a suitable grade of emery paper, preferably not coarser than No. 1. All dip tanks should be emptied and cleaned and the material strained through clean cheese-cloth or a sieve of not less than 100 mesh, or both, as often as is necessary for the protection of clean work. All tanks should be kept covered when not in use.

THE SOLVENT PROCESS is a new japanning system that has the features of very materially cutting finishing costs and at the same time producing a more satisfactory and superior japan finish than any of the old methods. Patents on this process are in process and in due time the readers may expect radical changes in handling and application which will revolutionize present methods.

This is logical because the application of two coats, each independently baked, in effect lays one on top of the other without any close bond between them.

However, in the double-coat idea the bond is positive because the first coat which is allowed to air-dry for a short period immediately takes on an initial set, being a drying oil compound. This means that the outer surface starts to harden and the hardening process, if allowed to continue, works its way inward toward the surface of the metal.

Next, the second dipping operation is performed, *not upon a first coat that is already baked, but one which has been permitted to air-dry somewhat with a thin crust of drying oil over it.* This crust is easily and readily cut by the reducer that is a part of the second dip material.

The result naturally is a *saw-tooth* or *dove-tailed* union between the first and the second coat and this followed by the single baking operation results in a finish that is more durable, uniform and far more water-proof than anything that has been produced heretofore.

Obviously, the initial cost of equipment can be greatly reduced as can also the cost of fuel. Too, the time required for the entire finishing operation may be cut considerably.

The Order of Application of different materials is most important. Five things must be considered in the applying of a colored enameled finish on a metal surface:

1. The anti-rust primer.
2. The undercoat.
3. The enamel.
4. Method of application.
5. Method of drying.

Some manufacturers use an additional anti-rust treatment on the metal before the anti-rust primer coat is applied. The advantages of this are: first, where the parts are kept in stock unfinished the anti-rust finish can be applied immediately upon completion of the manufacture of the metal work to prevent rusting during the time they are kept in storage; second, the anti-rust coat aids in securing covering and luster in the final finish coat.

The highest grade of colored enamel finish consists of four operations:

1. Anti-rust coat.
2. Primer coat.
3. Semi-gloss colored enamel, or a thin coat of gloss enamel.
4. Final colored enamel coat or a coat of clear gloss finishing varnish.

The surface of the metal must be thoroughly cleaned and free from rough spots, such as might be caused by rust. If there be grease on the metal the finish will not adhere. If it be rusty, the rust will, in time like a running sore, continue to work its way over the entire surface, even though well covered, and will eventually force the entire coating of enamel and primer from the surface.

MACHINE DIPPING is the best method to use when the production will warrant the expense. It has a number of obvious advantages over the hand method, but the particular advantage that would not be ordinarily apparent is the practical introduction of water foundation in the dipping tank.

Due to the physical property of oil floating on the surface of the water and not mixing with it, it is possible to reduce the amount of japan required in the dip; and, at the same time, reduce the fire hazard. The dirt automatically settles to the bottom of the water portion of the dip.

A United States letters patent granted to me on the floating of the japan on water has been assigned to the publishers of this book.

THE FLOCO PROCESS of applying japan is a comparatively new one. Although it has been used by many of the large automobile companies, little is known about it on the outside. It may be described as a *one side dip,* for it does everything that the dip does, except that it operates on only one side of an article at a time and does a cleaner and more satisfactory job.

Some japanners floco all the fenders that come into the shop to be refinished. So satisfactory do they find the process that no other method is used. It has been fully developed and has earned its place in the finishing room. Varnish and enamels may be handled also.

The equipment consists of a 15-gallon tank, a one-half horsepower motor, completely housed-in and driving a rotary pump; a regulator; a floco nozzle; electric fittings; flexible material hose and a galvanized iron drain trough. All parts, excepting the nozzle, hose and trough, are mounted on a portable truck. The truck is equipped with a rack around which to wind the hose when not in use as well as a holder for the nozzle (Figure 60).

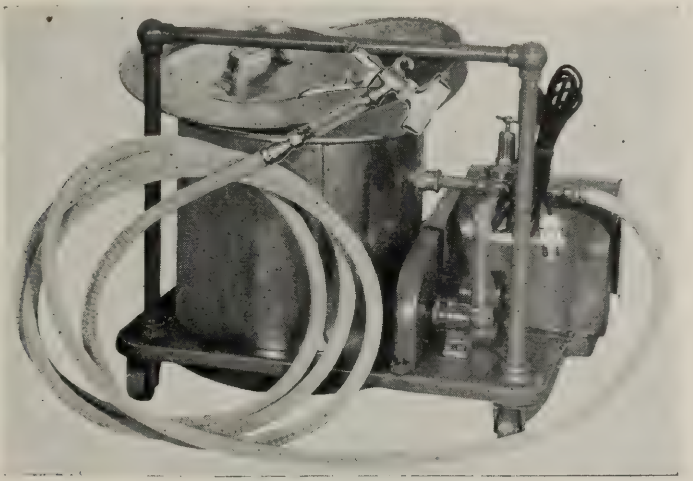

Figure 60—The Floco Outfit

The finishing material to be used is pumped from the bottom of the tank by the electric motor-driven pump, in a continuous stream through the flexible hose to the nozzle. The flow of material is adjusted by the regulator, by means of which only the required amount of material is delivered to the nozzle. The material not used at the nozzle is automatically returned to the tank through an overflow pipe. In this way the flow from the nozzle is instantly adaptable to any class of work or viscosity of material without changing the speed of the motor.

This nozzle has many advantages. It is balanced; the handle is angled so as to relieve all strain on the wrist; the lever, which operates the nozzle, fits in the hand perfectly, thereby making a natural and direct pressure which gives the operator an easy control of the nozzle. When the nozzle is closed the material is all pumped back into the tank through the overflow. This agitates the material in the tank, and is the only agitation that is necessary with materials which contain no pigment such as color varnishes.

The fender or whatever is to be flowed, is placed over the drain trough. The operator then flows the material all over it; afterward he flows it copiously over the sides or the upper half of the article. There is a sufficient amount of material applied to insure a perfect flow to the bottom. The article is then allowed to drain into the trough which carries the material back to the tank—here it is strained and, without the slightest waste, it is used over again.

Only a day's supply or enough material to handle the work, is placed in the tank. Fifteen gallons is the maximum amount of material exposed—the tank's capacity. The nozzle will operate just as satisfactorily with a gallon of material.

It is extremely simple to clean the equipment. The nozzle is detached and all of the material is pumped out of the tank. Then a small amount of naphtha or some similar material is put into the tank and pumped through the machine.

The motor is made for all kinds of currents and can be attached to any electric light socket; and, as the motor is only one-half horsepower the consumption of power is low.

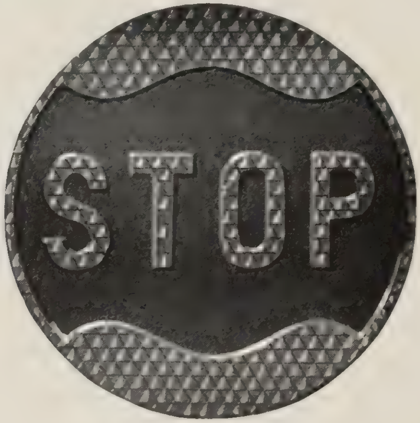

Figure 61—A Printed Lens

Printing is a late form of application of japanning having been invented by John Marshall Hayes and covered by patents assigned to the Lamberson Japanning Company. It is unfortunate that a complete description of this process cannot be given here at this time, but for certain reasons it must be withheld. Suffice to say that it is used principally in applying the japan to stop-light lenses (Figure 61), popular as warning signals on automobiles. It is by far the simplest process of application known, as by it one operator can japan six hundred (600) glass lenses, about 4 inches in diameter, per hour. Any design may be readily produced by this process, providing the surface to be covered is below the face of the surface. Automobile hub caps and bumper bar ornaments are just beginning to be finished by this simple method.

Hand Rolling or applying the japan or enamel by means of a coating machine is a process which has special applications. In the rolling method the parts are placed in a properly designed fixture and the material applied by pressing a suitable roller back and forth over them until the desired results are obtained. The roller is coated by passing it over a flat glass or metal surface covered with the desired material.

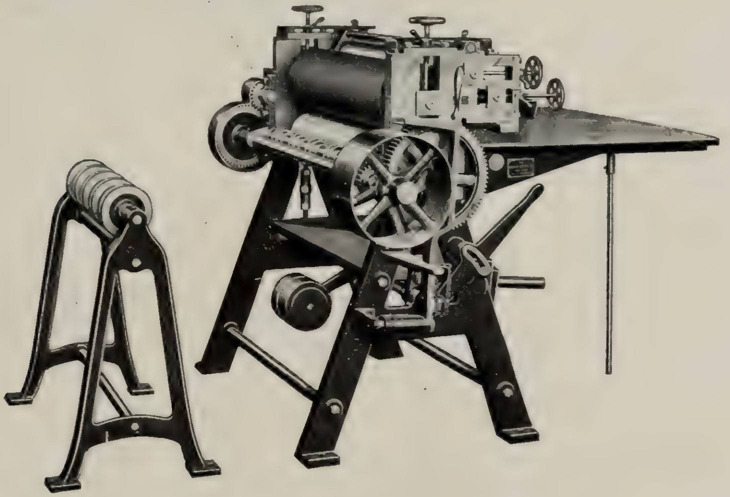

Figure 62—A Coating Machine

Machine Coating is similar to hand rolling except the parts are fed into the machine and coated mechanically similar to a printing process. Perhaps the best example of the use of this machine is the applying of the high lights, or second color, on automobile license plates.

Adjustments for the finest coating can be made almost instantly. Four rollers are used in the machine and none need to be removed for cleaning. When the machine (Figure 62) is running without sheets being fed, the supporting roller can be tripped as guides are so arranged that all surplus color returns directly to the fountain.

TUMBLING is a process of applying japan and enamels to small parts that can be tumbled together in a barrel, such as buttons and similar objects. The process is seldom used in the middle and western parts of the United States, yet is used extensively in the east, particularly in New England.

It consists of placing in the tumbling barrel a certain weight of parts to be enameled, together with a very small amount of japan—possibly a tablespoonful to five pounds of work. The tumbler is then operated at a speed of from 10 to 100 r.p.m., depending upon the work in the barrel for from a quarter to half an hour. This process is practically the same as dipping, except that it is carried out in revolving barrels. The parts are then placed on trays and baked.

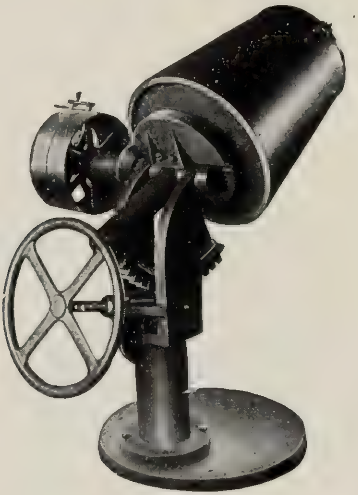

Figure 63—A TILTING TUMBLING BARREL

The japan must be tacky rather than in a thin and liquid condition. Special compositions are used which have shown quick-drying properties and a degree of hardness that offers resistance against rubbing and scratching even in the freshly applied state. This process saves paint (or whatever material is used), applies the coating in a way that gives close adhesion to every part, prevents the liquid from draining or drying in lumps and strings between the spaces or links, and gives a cleaner, harder and very resistant surface. If the parts require baking, the japan or other coating will show few blisters and come out of the oven with a superior finish. Wooden articles, such as pen holders, handles, toys, and so forth, are finished most satisfactorily by the tumbling process.

Japanning barrels are made larger at the bottom and smaller (Figure 63) at the top, due to the small amount of japan necessary to do a certain amount of work. With the oblique shape barrel the barrel is open at the top so that the operation can be watched and sample of work taken out and inspected without stopping the machine. The barrel can be tilted at different angles, to produce greater speed and this can be done while the barrel is in motion, if it is found necessary. The barrel can be filled while in operation by simply dumping a basket or box of articles into it. It may be emptied (Figure 64) by tilting downward. The work will then flow out into the container placed to receive it. This also can be done while the barrel is operating.

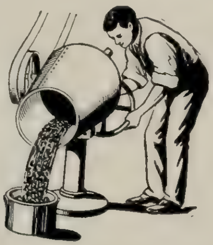

Figure 64—EMPTYING A TUMBLING BARREL

The following is a description of a process for finishing wooden handles used by one manufacturer:

> First, fill the tumbling barrel half full of raw handles; sprinkle one pint of rubber first coater, not reduced, over them; tumble for half an hour. Dump the handles out and put on racks and bake at a temperature a little higher than enamel would ordinarily call for to drive moisture out of the wood and prevent blistering. As soon as the handles are baked and before they cool (that is, while they are lukewarm), dip in rubber first coat at a gravity of 35. To bake at regular heat first-

coat rubber requires a slow heat at the start and ample time to drain off before putting the handles in the oven. Before the handles get real cold dip them in the finishing coat reduced to 35 gravity and proceed as in the case of the first coat.

In order to obtain an oak finish fill the tumbling barrel half full of handles and sprinkle over them one-half pint of oak stain. Next, sprinkle in one heaping tablespoonful of whiting. Tumble the handles for half an hour and then add four ounces of shellac, tumble some more and keep on adding less shellac at the end of each half hour.

To obtain a pure white finish use paraffin oil instead of oak filler and proceed as above.

Drill one-half inch holes in both ends of tumbling barrel for purpose of giving air to the product; and nail cleats longitudinally on the sides of the barrel in order to prevent the handles from sliding.

A first-coat rubber reduced 100% is used on snap fasteners and must be baked hard before the second coat is applied. The second-coat material should be reduced about 50%. The success of the whole process lies in putting on very thin coats.

Often the parts can be sanded, before japanning, by tumbling, but, of course, this would have to be done in a separate barrel used for that purpose only. For cleaning about 50 pounds of work, in a tumbling barrel, mix up the cleaning compound as follows:

7 pounds fine white sand
14 pounds No. 0 pumice stone
Water to make paste.

Add more water if the parts stick together, and tumble for about nine hours. Wash thoroughly in running water.

Some very satisfactory experiments are now being made by inserting slats inside of the barrel, parallel with the axis and 90 degrees apart. Also, very good success has been met by spraying the japan onto the parts while the barrel is in motion.

XIII

OVEN DESIGN

The Outward Appearance
Design
Insulation
Mineral Wool
Sheet Asbestos
Diatomaceous Earth
Ventilation and Circulation
Heat Travels in Three Ways
General Safety Precautions
Coke Ovens
Temperatures
Stove Ovens
Steam Ovens
Fuel Oil Ovens
Electric Ovens
Specifications
Locating the Oven

The Outward Appearance of a japanning oven indicates that it is one of the simplest pieces of mechanical equipment, yet this simple looking enclosure has caused many disastrous fires and explosions. Men who desire to do their own japanning, who either do not wish or are not able for some reason to send their work to a japanner, who makes a specialty of that work, are responsible for this reputation. Why? Principally because in attempting to build their own ovens they make some ridiculous mistakes and often create working conditions for the men that are most unbearable. It is obvious that japanning ovens are complicated as to design and efficiency.

My own company's early history is a good example, for the men in charge[1] were expert japanners. This plant was wrecked by an explosion which was caused by attempting to light a gas-filled oven. Every window in the building was blown out.

If such a thing happened to experienced men is it not reasonable to expect that it *might happen* to inexperienced or ignorant men? Indeed very few serious explosions have taken place in japanning-job shops. Nearly all of the serious ones have occurred in plants which have been home-made.

A prominent baby carriage manufacturer, for example, who was determined to save the profit he might have to pay to a reliable oven manufacturer, decided to build his own oven. He had had one sad experience with a home-made oven and he was determined to at least make the second one explosion-proof so that his office, which was on the second floor, might be protected. To accomplish this he proceeded to build the japanning department into a specially constructed one-story brick building on the adjoining lot. The one-story building was about 25 by 50 feet and the japanning oven proper occupied about one-half of this. A novel feature of the design was the roof of this one-story building which was made of reinforced concrete, one foot thick throughout.

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[1] See Figure 1, page 6.

It was thought that this would confine any explosion within this building so that the office would be safe. That part worked out fine in theory, but what actually happened was—one night the watchman went into the japanning department on some errand. He lighted a match which ignited a volume of gas that had filled a space 8 feet by 25 feet by 50 feet from a leaky or open, valve. An expressman who happened to be near made this statement: "As I was passing this plant I heard a great noise. I looked in that direction. The whole roof seemed to raise about two feet, then the walls fell outward and finally the roof dropped to the ground." The author personally inspected the ruins the following morning and there was not a single square foot of the reinforced concrete roof left intact in the ruins. Of course, the watchman was killed. There have been many just such explosions in japanning rooms in manufacturing plants (they are never heard of outside the plant itself), due to the thoughtlessness, carelessness, or neglect of either those in charge of the operation or of those who designed the plant.

In talking with a foreman in charge of a dangerous type of japanning oven, he said that he had been operating it for 10 years, and had never once let anyone else touch it. He had had very little trouble with it since he knew the entire system like a book. Now, the point is that the foreman was one in a thousand! Had he, during those 10 years, allowed understudies to take care of that oven the instructions given (in the labor-turnover) might have been far from the original and might actually have been reversed.

Unless a japanning department is supervised by just such an honest, careful, and dependable foreman as the one mentioned (if he has a home-made or an open-flame oven), it is better to either send his work to an outside japanner or modernize his japanning department by buying an oven from a reliable japanning-oven manufacturer. The fire and explosion danger in *modern* japanning equipment has been reduced to a minimum by proper design, construction, and safety appliances.

Generally speaking, japanning ovens are box shaped containers built mechanically strong to take a full load of metal articles to which a coat of "wet" japan has been applied. These articles are then baked long enough and at high enough heat to transform the "wet" japan coating to a dry, hard, glossy surface. That sounds simple, but there are some very important points to be taken into consideration.

Design in an oven consists of a strong flexible structure having narrow panels with telescoping joints and insulated against heat loss at every point. The wall thickness should in general be at least four inches, except where low cost of heat, moderate working temperatures or infrequent operation makes a two-inch wall economical.

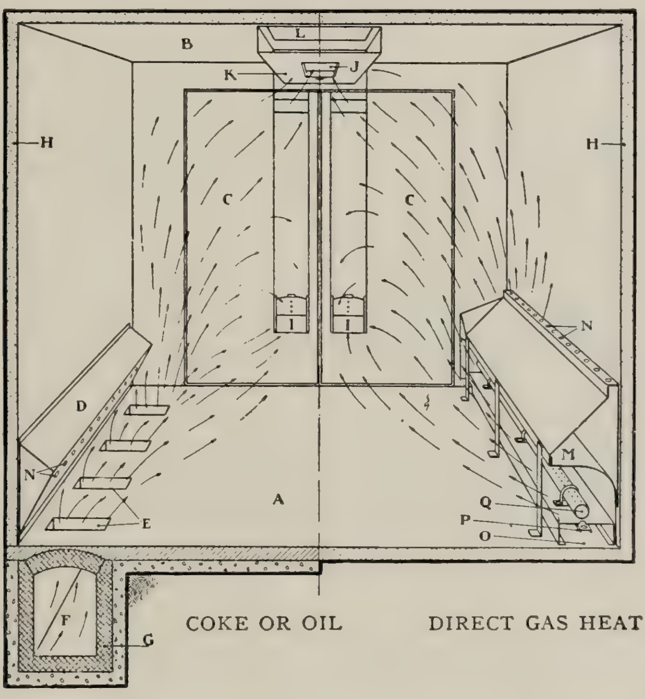


Figure 65—Diagram Showing Oven Ventilation and Circulation

Insulated floors of either portable or stationary ovens are usually made up of panels, similar to those used in the walls and roof. In larger ovens, resting on a fire-proof base, a steel-plate floor with insulation between the stiffening angles is used. Where the building floor is of wood, a first course of heat insulating brick should be used to give complete protection.

Among other construction details are preheating and recirculation baffles and vent systems for natural and mechanical draft (Figure 65). Where oven walls are less than 10 feet high vertical panels are usually used.

The important points are:

1. Shape of oven and character of its equipment
2. Heat insulation
3. Proper ventilation and circulation
4. Fire hazard

Here, coke or oil heat is illustrated on one side and direct gas on the other.

The following letters designate the various oven parts:

A—Floor
B—Roof
C—Doors
D—Fresh air duct and baffle
E—Openings for heat through floor
F—Heating flue
G—Fire brick
H—Side walls
I—Floor vents
J—Roof vents
K—Roof breeching
L—Outside vent
M—Burner baffle
N—Pre-heated fresh air
O—Secondary air
P—Secondary air slide
Q—Burner

Fundamentally, japanning ovens of proper design produce, retain and apply heat. The *useful heat energy* is indicated by the following:

1. Heat absorption by the parts being baked including carriers for work
2. Heat used in driving off the volatile part of the coating material
3. Heat consumed in inducing initial draft to start ventilation
4. Heating fresh air
5. Insulation absorption and radiation

The *wasted heat energy* may be accounted for in part as follows:

1. Poor insulation
2. Loose joints
3. Continuous metal from the inner to the outer walls
4. Poor floors
5. Incomplete combustion
6. Air leaks
7. Unused heat that escapes with the air and the gases
8. Smothering action due to poor ventilation and circulation

Insulation has improved much in grade. Much credit is due the makers of the better grades for the progress made. Among the points of loss just mentioned insulation is one generally recognized as very important. However, its careful selection alone will not insure a good oven. Other points must also be seriously considered.

Referring to Figure 66, A represents the useful and waste heat in an oven of at least average insulation and design. Changing this oven to the best insulation known gives increased useful heat as shown by B. It is not possible in an illustration of this kind to consider such uncertain items as air leaks and smothering action. However, changing this same oven to the very best design as well as the best insulation increases the useful heat still more, as shown in C. These diagrams visualize the great importance of good design and tell the story much better than words.

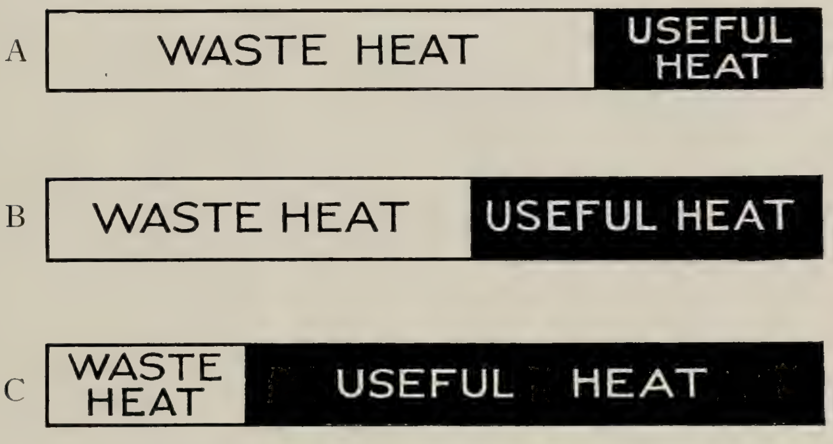


Figure 66—Oven Heat Losses

In an average oven little attention is given to the joints. This results in a continuous loss of heat. Filling-in or cementing cannot offset this loss as continuous metal is present to conduct heat. It is impracticable to build any but the smallest oven without joints.

The convenient, panel-type oven of the present time has proven its desirability in comparison with the large and unwieldy solid wall type of former days. Joints in the panel type oven (Figure 67) should be strong, flexible, and should have good insulation used in them. The connection of roof and side-wall panel (Figure 68) is also made in a non-conductive manner and eliminates the former corner joints where through metal was unavoidable.

Heat insulation is a very important factor in reducing costs and increasing output. Primarily an oven is made to hold heat. Great care must be used in selecting the insulation, but such care avails little where this is counteracted by metal through the walls, or by other weaknesses of design. The weight of a unit volume of insulation is a fair indication of its efficiency. All heat insulations depend upon the air they contain and upon the extent to which they prevent this air from circulating. Hence light weight insulation as well as one having air pockets which are so small that they are invisible is very desirable. Insulation (Table 13) must not only be incombustible (except for steam-heated ovens) but it should withstand without injury an excessive temperature which the oven might accidentally reach.

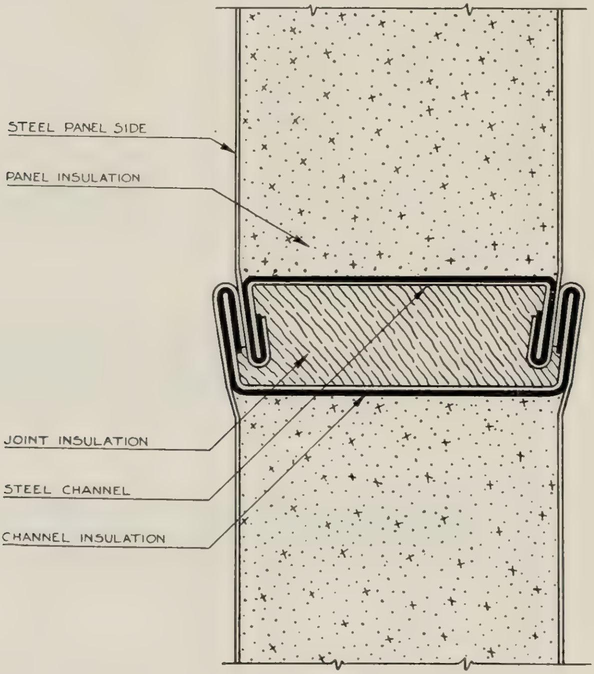


Figure 67—Section of Boltless Joint

The insulation should be efficient. The material composing it should be a poor heat conductor, thus minimizing *conduction* of heat. It should be porous, containing multitudes of microscopic air cells, giving the great advantage of *dead air*. These cells should be so small that the air within cannot circulate. Convection occurs when comparatively large air pockets are present. Such pockets as well as unfilled hollow walls are also subject to internal radiation transmission losses.

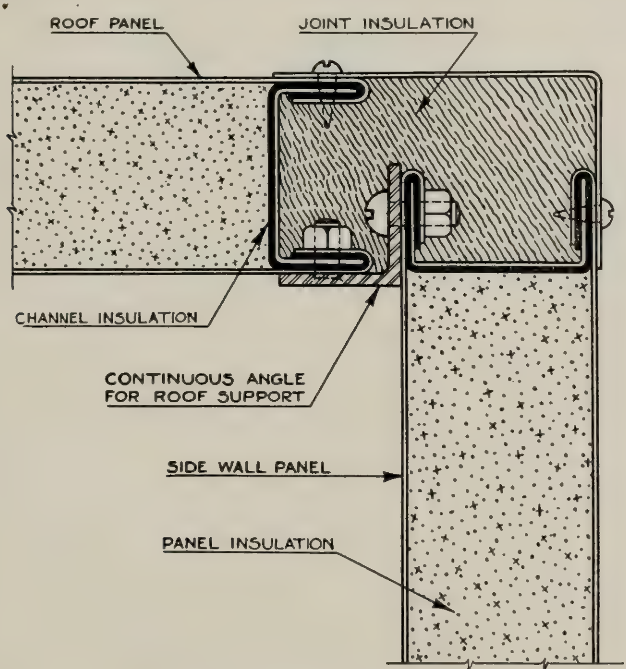


Figure 68—SECTION OF ROOF JOINT

MINERAL WOOL as an insulation is objectionable, principally because it packs and settles, thus giving away inside the oven wall.

SHEET ASBESTOS comes in different thicknesses. It may be used in one or in several layers. However, it is somewhat expensive to use in the sheet form. It also comes in bulk.

DIATOMACEOUS EARTH (also called Kieselguhr) is used for insulating japanning ovens of the better grade. It is a peculiar white substance of very low specific gravity. It is a decomposed sea-weed made up of a billion little cells (Figure 69) to the cubic inch. Each of these cells contain air. That means it is an excellent non-conductor of heat. It is marketed in blocks from 1 to 3 inches thick; 6 to 12 inches wide; and 18 to 36 inches long. It also comes in the form of a powder which is used for filling in the joints between the blocks.

VENTILATION AND CIRCULATION of air currents in ovens should be given careful attention. It should not be difficult for one to see the folly of using open-flame gas or other burners, in the presence of inflammable benzine fumes and actual dripping of the japan itself on the burners or on the baffle plates that are usually placed over the burners.

TABLE 13

INSULATION TABLE

KIND	WEIGHT PER CUBIC FOOT	MELTING POINT DEGREES F.	CRUSHING STRENGTH POUNDS PER SQUARE FOOT	THERMAL CONDUCTIVITY*
Mineral Wool		2552		.37
Prepared Brick	32	2930	440	.58
Asbestos	36			.66
Diatomaceous earth or Kieselguhr				
powder	15	2930	401	.36
brick	35	2930	401	.50
loose				.59
Fire brick	120	3000-3256	3600 at 2700° F.	.10

*B. t. u. per inch thickness per square foot per degree F. difference in temperature.

Circulation must distribute the fresh air and equalize the temperature to secure uniform baking. Ventilating systems vary with conditions and oven size, a small oven being cared for very simply. A typical ventilating system is shown (Figure 70). Fresh-air ducts

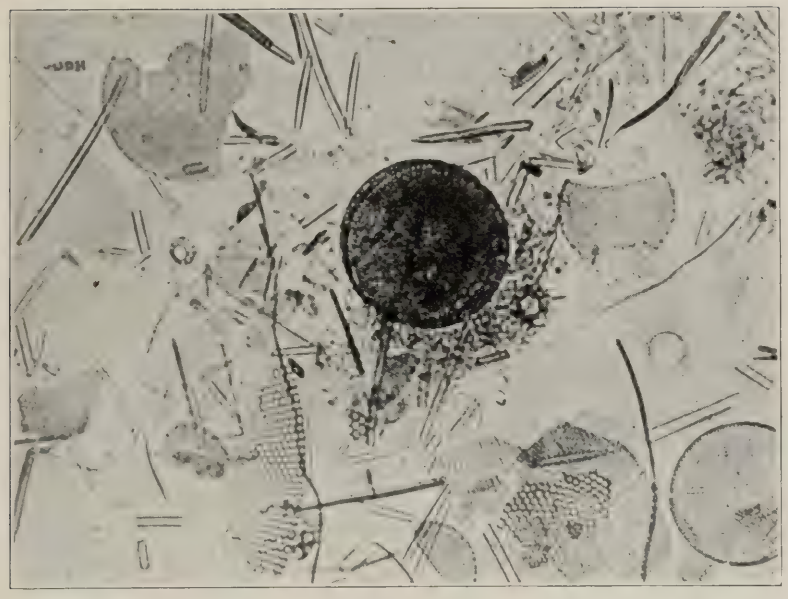
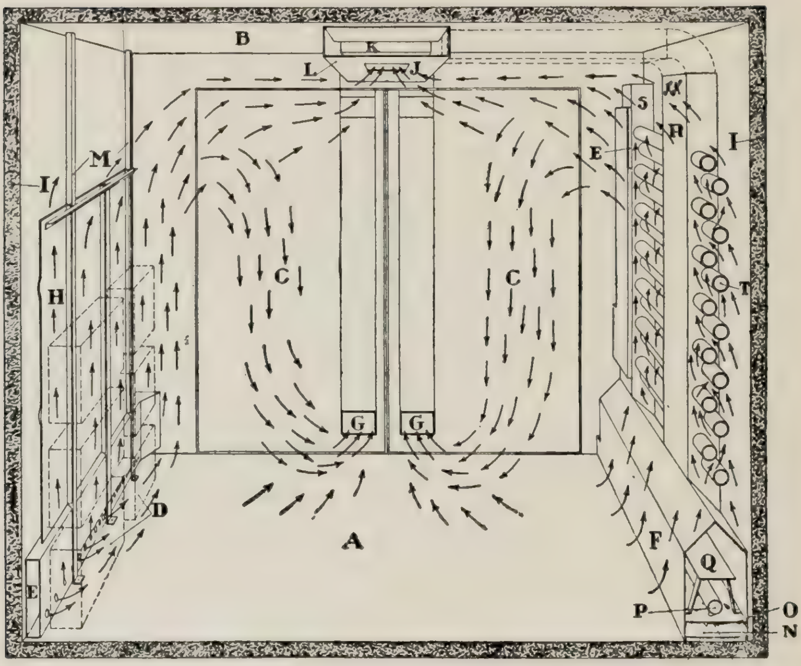


Figure 69—Diatomaceous Earth (Under the Microscope)

extend along the sides and out at the front and back. All incoming air enters these. As the ducts are close to the heating units, the air becomes preheated before entering the baking compartment. Heated air currents rise at the sides of the oven.

Vents having independent dampers in some cases are supplied at the top and bottom, both at front and back. Ordinarily, during the first part of the bake, all these vents are open. Part of the rising air goes through the roof vents, carrying with it fumes or moisture from the upper part of the oven. Part of the fresh air drops as it gives up heat to the product and is drawn out through the bottom vents. The air thus circulates throughout the oven, supplies oxygen and equalizes temperatures. As the drying proceeds the top vents are nearly closed. The heavy, less heated air settles to the floor and is thus drawn out through the bottom vents.

Japanning ovens should be easy to clean. Where fumes arise during the baking a part condenses upon the inner walls. The joints should be smooth and have no prejecting bolt heads. Such bolts often become loose and as the oven draft pulls air through them as well as through loose joints, dirt enters from the outside. In some cases pulverizing insulation becomes a factor.



ELECTRIC HEAT INDIRECT GAS HEAT

Figure 70—Diagram Showing Oven Ventilation and Circulation

The following letters indicate the various oven parts in Figure 70:

A—Floor
B—Roof
C—Doors
D—Electric heater locations
E—Fresh air duct
F—Indirect gas heater
G—Floor vents
H—Wall shields
I—Side walls
J—Roof vent
K—Outside vent
L—Vent breeching
M—Electric heater supports
N—Secondary air duct
O—Secondary air slide
P—Burner
Q—Burner baffle
R—Outlet manifold
S—Manifold
T—Radiator tubes

The easiest way to secure good ventilation is to force air through the oven by means of a blower located either inside or outside of the oven. Air that is blown into the oven may be heated outside of the oven; or, it may run through ducts within the oven so that it becomes heated before reaching the large chamber of the oven. It may even enter the oven cold. The last condition is not a desirable one as it tends to cool the oven, especially where the air enters.

Attempts have been made, and with occasional success, to use a gravity system of ventilation, doing away with the necessity of a blower. The difficulty lies in the fact that it is the foul gases which ventilation is supposed to remove from the oven. These gases, being heavier than the air, go to the bottom of the oven where they come in contact with, for instance, steam coils. They become highly heated so that their gravity lessens and they move up again. This constant motion prevents any positive gravity action, so at best, such systems are only partially effective and not at all to be compared with the positive ventilation system in which a blower is used.

In one type of oven in which direct heating is used, steam coils on the floor supply the heat units. Air is blown into the oven in a wide, shallow duct, which passes close to the steam coils so that the air becomes warm before it leaves the duct. The arrangement of the duct is such that the air comes out of it at one end of the oven and passes down the length of the oven, forcing the gases by means of two round pipes leading upward through the roof and out of doors. These round pipes come to within six inches of the floor line.

Heat Travels in Three Ways—by radiation, by conduction, and by convection.

The first is not so important in connection with japanning ovens. Use of *corrugated* iron for the outside metal increases the radiating surface of the oven somewhat and consequently causes a heat loss that is more and more noticeable as the thickness of the insulation is reduced.

Heat is conducted from one particle of matter to another by the impact of the molecules in the material. If a flame be allowed to impinge on one side of a plate, the other side will soon get hot. This is exactly the process which takes place in any heat insulating material. The molecules composing the inner surface first become heated from contact with a hot surface or air and are thus excited to rapid movement. Gradually this molecular vibration extends farther into the insulation. The lower the heat conductivity the less rapidly does it pass from one side to the other. Eventually, however, more or less of the molecular vibration reaches the surface, the result being that a portion of the heat is dissipated in the surrounding atmosphere.

No material is absolutely heat-proof. Some materials, though, present fewer obstacles to its passage than others. For instance, the heat conductivity of heavy, dense substances is great; the conductivity of lighter, less dense materials is less, probably because the molecules are not so close together. Wood transmits much less heat than metal. The heat conductivity of gases is still less; hence, air, the most available gas, is the most efficient insulating medium that can be had, if a vacuum which is commercially impracticable on a large scale, be left out of consideration. The difficulty, however, is to confine air so that it cannot circulate, for the transmission of heat is effected by still another means called convection, which is defined as the carrying of heat from one object or place to another through the agency of any moving gas or fluid.

The principle of convection is well illustrated in an ordinary house furnace. The rooms are warmed by circulation. In the hot-water heating system, water is the medium utilized to carry the heat from the boiler to the room to be heated. No mechanical means has to be employed to make the water circulate. Ducts for air or pipes for water are provided and the hot air or hot water as the case may be rises as it is warmed and drops as it becomes cool, thus automatically setting up circulation.

The only way by which a circulatory process similar to this can be prevented from taking place in heat insulation is by confining the air in very minute particles. Of course, the greater number of dead-air spaces that can be made to intervene between the hot pipe or boiler, and the outer air, the less will be the amount of heat lost. Hence, the most efficient heat insulation may fairly be said to be that which contains the largest amount of dead air, or, in other words, that insulation which contains the greatest number of the smallest possible air spaces.

General Safety Precautions in the design of gas-heated ovens must be considered, but no matter what kind of fuel is used every effort possible should be taken to prevent accidents occurring.

Several types of gas ovens are in use at the present time, and the safety or danger of these appliances lies partly in the details of design and construction. If there is uncertainty as to a particular oven it is well for the purchaser to observe the following points of construction which will be included in an approved oven and which are of special significance from a safety standpoint. One of the most important safety features of an oven is the arrangement of the oven burners whether direct or indirect.

The burners of an oven consume a comparatively large volume of gas in a given time and some safe means should be provided to light them. All open flame ovens should be so constructed that the oven door must be opened before the oven burners can be lighted. Failure of the gas to ignite immediately may result in an accumulation of a mixture of gas and air which would cause a small explosion that may ignite the clothing or burn the hands or face of the workman.

To make lighting of the burners safe and easy a good design is necessary. The pilot burner should be of such a type that it will ignite the gas at the main burners instantly, and it should in no way interefere with proper combustion of gas in those burners.

A japanning oven should be so constructed that the watchman can easily see whether the burners are lighted at any time, preferably without even opening the door. In all cases the oven door should be constructed so that it will open readily of itself if any pressure occurs inside the oven. The effects of any slight gas explosion in the oven, should one occur, are thus rendered less harmful.

The cocks on ovens are an important part of the appliance and should be well made and carefully kept in order. They should have a stop-pin to prevent turning too far when the intention is only to shut off the gas. A spring washer to hold the plug firmly in place is desirable. Any loose or dirty appliances should be cleaned or repaired promptly.

The cleaning and adjustment of the burners to maintain a clear blue flame is also important. In such adjustment the small flame at each orifice on the burner should be distinct and have a sharply defined inner cone. It is not desirable, however, to open the air shutter so wide as to make the flame noisy or to permit flashing back of the flame.

A well-constructed oven is so well insulated internally that it should not become hot enough, even after continued use, to be likely to ignite combustible materials if kept reasonably distant from it. A free air space, through six-inch hollow tile, between the oven and the floor and walls will generally suffice to make the danger from fire negligible.

Coke Ovens (old fashioned) are little better than stove ovens, because they are usually built so that the fire portion is below the japanning floor. Since they were constructed of brick they are not portable. The same objections mentioned for stove ovens would also apply to coke ovens.

Temperatures in japanning ovens should be carefully considered for the articles in the oven may be injured by too high a heat. Table 14 will give an idea of the range for different materials. Sometimes japanning ovens are used for tempering articles such as bed springs and so forth, after which they are coated with japan.

Table 14

Approximate Temperatures

Name	For	Degrees F.
Air-Dry Blacks	Baking	250 to 325
Solder—		
Fine	Melting	340
Common	Melting	370
Cheap	Melting	440
Steel—		
Faint Yellow	Drawing Temper	430
Yellow-orange Straw	Drawing Temper	460
Orange	Drawing Temper	470
Orange-Yellow	Drawing Temper	500
Red-Violet	Drawing Temper	530
Violet	Drawing Temper	550
Blue-Violet	Drawing Temper	560
Blue	Drawing Temper	600
Green	Drawing Temper	630
Green	Drawing Temper	700
Color of steel—		
Bright red	In the dark	752
Red	In the twilight	884
Red	In the daylight	1077

All colors are more or less affected by heat.[1] They lose their brilliancy, become very much darker and sometimes turn black at too high a heat. White will turn a beautiful brown if permitted to remain in the oven up to 400 degrees F. Gray will turn olive-green under the same conditions. Prolonged heat (not too high) kills the elasticity of the enamel. It does not visibly affect the color. To assure the billiancy of the color the following heats (Table 15) may be used with safety:

---

[1] See *Practical Color Simplified,* Chapter VIII, for further information.

TABLE 15

BAKING TIME AND TEMPERATURES

COLOR	TIME HOURS	TEMPERATURE DEGREES F.
White	4	120 to 225
Light Blue	3	200 to 225
Light Green	3	200 to 225
Light Yellow	3	200 to 225
Gray	4	120 to 225
Red	3	200 to 225
Green	3	200 to 225
Yellow	3	200 to 225
Dark Blue	3	200 to 225
Olive-Green	3	200 to 225
Maroon	3	200 to 250
Black	1 to 4	375 to 550

STOVE OVENS were, perhaps the oldest and the first ovens used for japanning. They have the following disadvantages:

1. The fuel in the stove consumes the oxygen from the air, which retards the drying.
2. The oven is very hot near the stove and comparatively cool at the places remote from the stove.
3. The stove itself occupies valuable oven space.
4. Black japan heats cannot be run in them in less than four hours which means that only one heat a day is practical.
5. Work that is not above two feet from the floor is not likely to be baked properly.

It must be said though that the quality of the work turned out in these old brick ovens has no equal today due principally to the length of baking time.

STEAM OVENS consisting of a sufficient number of steam pipes to run the temperature up to 125 degrees F. or 200 degrees F. are used to some extent in plants where there is a large supply of power, but they are not used extensively because of the slow output.

Superheated steam ovens are in the same class as steam ovens, except that in them higher temperatures may be reached.

Fuel Oil Ovens are now being used. Their successful application has been worked out so that the source of heat is far removed from the oven compartment, such as in the convected heat type of oven described elsewhere.

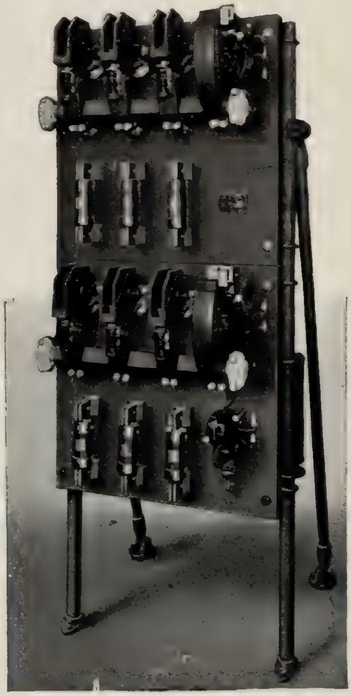


Figure 71—Electric Switch Control Panel (Front View)

Electric Ovens (direct heated) are in general to be preferred in a great many ways, if the locality in which they are installed be one where the cost of electricity is not excessive.

They are direct heated, but are not dangerous like direct gas flame ovens, because the electric heating units are uniformly distributed along the side walls. Also, the heat being distributed over a larger area within the oven is not concentrated as it is in the direct gas flame oven.

Electricity, creating no gases, is direct in its application and indirect in its effect. The simple construction of typical heaters is shown and needs no description. The heating ribbon which carries the current is a special metal. The units are mounted at various points so as to give the most advantageous heat distribution by aiding the circulating system. A properly connected system of steel bus bars gives maximum efficiency and flexibility of control. The control panel (Figure 71) is located just outside the oven and usually includes automatic temperature control, solenoid switch, signal light, main switch, and fuses. A door switch is so connected that current is cut off when any door is open.

Specifications that govern the design features of ovens may be listed as follows:

- Size of Oven
  - Number and sizes of parts
  - Number of bakes for each part
  - Time of bake
- Temperature
  - The process and
  - Kind of material
  - Time of baking
- Heat Capacity
  - Time
  - Load
  - Temperature

In Table 16 will be found the usual points that have to be considered in the purchase of a japanning installation.

Table 16

Oven Data Desired

*1. Baking process (as japanning, etc.)..
*2. Color ....
*3. Maximum temperature desired...
*4. Length of each bake...
*5. Hours oven is operated per day...
*6. How many (coats or) bakes does work receive?...........................
7. How is finish to be applied (as dipped, sprayed, brushed, or flowed)?..........
*8. Product to be baked..
*9. Material of which the product is made.......................................
*10. Overall dimensions average parts...

*11. Average number of parts per bake..
12. What limits the baking temperature (solder, wood, glue or what)?..............
*13. Weight of average part..
*14. Total weight of metal per oven compartment in the parts for handling work...
15. Describe present method of doing work......................................
*16. Method of handling work: (as truck, lift rack, conveyor, etc.)................
*17. Overall dimensions of loaded truck or rack, etc...............................
..........wide..........long..........high.
18. Distance from floor to lowest part of work...................................
19. If trucks or car, distance between wheel centers (gauge), etc..................
....................and width of wheel faces.................................
*20. If work is trayed; size tray...
*21. Number of layers high in oven...
22. If work permits "nesting" as in hollow open parts, give distance between centers: Across oven..
Along oven depth...
In height ....
*23. Number of trucks per compartment...
*24. Number of compartments desired (sketch floor plan showing arrangement)....
25. Swing of lift doors...
*26. Doors, one or both ends..
27. Are walls to be 2 inches or 4 inches thick?...................................
*28. If you have determined it, give the net baking space required for an oven load
..........wide..........deep..........high
29. Natural or mechanical draft...
30. If latter, kind of current for motor..
*31. Method of heating preferred..
*32. If electric, name the make of heaters (if preference):
Voltage of current..................DC—AC.........................
If latter, cycles and phases (1, 2, 3).................................
*33. If gas, kind..............................Pressure.......................
*34. If steam, pressure at oven...
35. On which floor will oven be located?...
36. Net ceiling height ....
37. Number of stories in building..
38. Material of floor where oven is located.......................................
*39. Floor space available..
40. Height of adjoining buildings...
41. Where possible, send building plans and indicate where oven is to be installed.
Designate other items wanted below:
Oil burners ....
Steam coils ....
Automatic temperature control..
Recording thermometer ....
Conveyors ....
Trucks or lift rack, and number..
Lift trucks, and number...
Dip tanks ....
Drain boards ....
Gas booster ....
Outside vents (give sketch, showing dimensions and nature of run)...........
....

---

*Important data.

Locating the Oven is closely associated with its design and just to show what has been done to save floor space, an illustration (Figure 72) shows how a place for the oven has been found in a space that cannot be capitalized very readily in other ways.

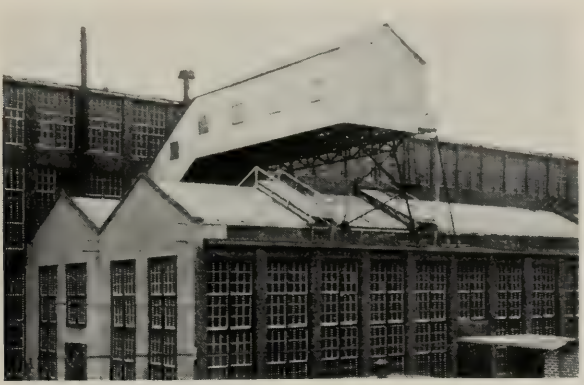


Figure 72—Locating an Oven to Save Floor Space

The dipping end of this continuous conveyor, of course, is located inside the building. The parts are carried up on the roof within the enclosure, baked and returned to the dip where the same operator who places them on the conveyor takes them off.

XIV

GAS-BURNERS

Gas-burners in General
Atmospheric Burners
Fan-blast Burners
Fan-motor Blowers
Positive Pressure Pumps
Natural Gas

Gas-burners in General and their careful design are an important item in connection with baked finishing. All fuels in burning require an amount of air many times the weight of the fuel. If enough air is not supplied, part of the fuel will not burn; if too much air be supplied, an unnecessary amount of heat will be carried away in the smoke. The choice of different fuels depends upon how completely they are burned.

Coal is usually not entirely burned since unburned pieces are found in the ashes. Gas is not always entirely burned. The truth of this is hard to believe because unburned gas is not visible. *Partly burned gas* is always dangerous, since it contains more or less poisonous carbon monoxide gas which is produced when a burner "strikes back" or burns in the tube.

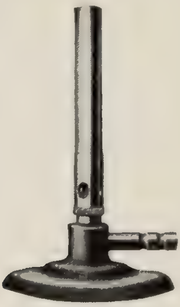


Figure 73—Diagram of Simple Atmospheric Gas-burner

Carbon monoxide gas is also produced when an ordinary gas, oil, or gasoline flame plays upon a cold surface. Partly burned gas can almost always be detected by a pungent odor. This is not the odor of carbon monoxide, but some of the latter is almost always present when there is such an odor. On account of the danger of carbon monoxide gas all ovens should be supplied with vents to carry off dangerous or partly burned gases. *Oven burners should be adjusted so that the green central part of the flame is about half the height of the whole flame.* If the flame is very long and bright yellow in parts, too little air is being admitted; if short and noisy, that is an indication of too much air. The amount of air supplied to gas-burners is usually controlled by an adjustment found in the burner.

City gas may consist of what is known as water gas which is largely carbon monoxide, or it may consist of coal gas which is chiefly hydrogen. Again, it may be a combination of the two. Natural gas is a complex substance and contains both carbon and hydrogen in somewhat complex form. Due to the fact that much air is needed for combustion, all of which cannot be drawn in through the holes at the base (owing to the low pressure at which gas is ordinarily distributed, in cities) the flame is relatively long. The length of this flame may be materially reduced by even a slight pressure back of the air; one to two ounces in the case of fan blast with the burner design properly arranged being all that is usually necessary.

Atmospheric Burners, the kind used in stationary japanning ovens, operate on what is called *the Bunsen principle* (Figure 73). It employs the pressure back of the gas as usually delivered in the city mains. Such a burner (Figure 74) consists essentially of four parts: 1, the cock or valves; 2, the air mixer, shutter and orifice; 3, the mixer pipe, and, 4, the head. The mixer consists of a body which contains a threaded nipple and air shutter at the end nearest to the cock. At the burner end there is a small brass tube drilled with a hole of relatively small diameter. As the gas passes through this opening, the passageway being small, the velocity of the gas becomes relatively very high. Therefore, it rushes into the mixer pipe (Figure 75) with the result that it draws air in through a space made between the shutter and the body of the burner.

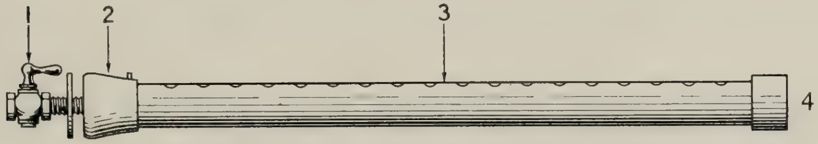


Figure 74—Atmospheric Gas Oven Burner

The mixture of gas and air passes on to the head of the burner and comes out of the holes. When a burner is operated atmospherically the force of the gas delivered is seldom sufficient to entrain all the air necessary for combustion. It usually only entrains about half the amount necessary. Theoretically, the amount of air required to burn city gas completely is about six parts of air to one of gas, so that three parts of the air might be drawn in through the mixers and the other three parts of air would have to be obtained from the space around the flame or flames. The air which is drawn in through the mixer is termed *primary air*. The air around the heads used to mingle with the flames is referred to as *secondary air*.

Because the japan fumes sometimes interfere with combustion, the available secondary air is often not sufficient so that a separate secondary air duct is provided directly below the burner. The duct has openings outside the oven to the room at both ends, one being at the front of the oven and the other at the rear.

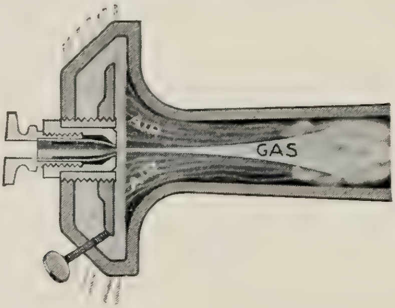


Figure 75—Cross-section of a Gas Mixer (Atmospheric)

Fan-blast Burners operate in a manner practically the reverse of atmospheric burners. Instead of the gas pressure being utilized to entrain the air, the air is put under a certain pressure and is used to draw in the gas. For this reason it will be noted that there are always two connections on a blast burner; the straight pipe is connected with the air line (A) and the off-set is connected with the gas (G) (Figure 76). The nipple (I) connecting the gas valve and the reducer (C) may be shortened if necessary. Upon the gas distributing pipe (D) is mounted the blast burners (B). The burner is held in position by the support (S) and the flames are deflected by the plate (T) held in position by the brace (K).

The pressure back of the air increases the velocity of the mixture in the connecting or mixer pipe used between the entrance connections and the burner proper. The pressure back of the gas also helps.

The velocity of the mixture having been increased, emerges from the burner at a higher velocity than is the case of an atmospheric burner. This means that combustion takes place at a faster rate. In other words, it is possible to burn more gas in a certain time in a certain space than would be possible with an atmospheric burner.

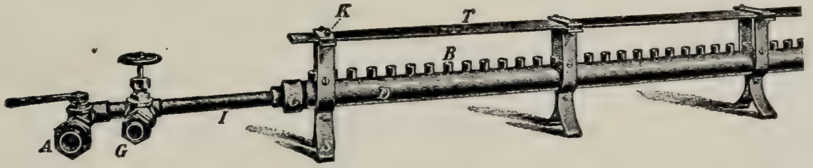


Figure 76—Gas-burner (Fan-blast Type)

Therefore when a blast burner is used the burner head may be made smaller if desired. The only difference between fan blast and positive pressure blast is a relative one; fan blast has air delivered at a pressure of about one or two ounces per square inch which is usually all that is required for satisfactory operation; positive pressure air approximates a pressure of one to five pounds per square inch.

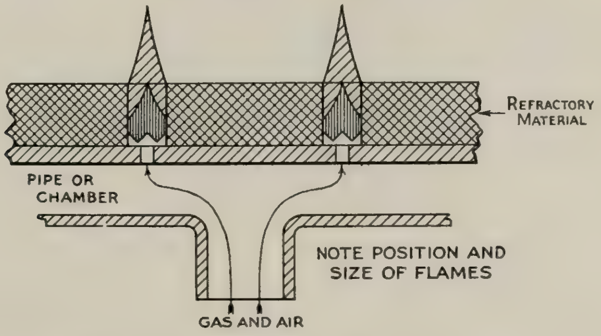


Figure 77—Diagram of a Tubular Blast Burner

Air at greater pressures is also used in certain special cases, but is not recommended owing to the fact that a special construction is often required in the burners. It is safe to say that where very high pressure air is available it is more convenient to have an independent blower to take care of any burners which may be operated by fan blast. At the same time a burner designed for fan blast cannot be used for positive pressure blast or vice versa unless certain changes are made in the mixing devices.

Due to the fact that a fan blower operates on the principle of *not* building up any pressure and operates at the same time at a low pressure, the cost for the electrical energy is usually very small and figures out at only about 1/10 of the cost of that for positive pressure.

Blast burners have another advantage over ordinary burners when, for example, an ordinary domestic kettle is placed over a gas flame it will be found that there is quite a space unoccupied by any flame between the flame itself and the bottom of the kettle. Very often the thickness of this space may be ⅛ inch. It consists of burnt or unburnt gases which are formed due to the cooling effect of the kettle which still remains there to a more or less degree whether the kettle contains water at only 50 degrees F. or at boiling point (212 degrees F.). It is desirable to avoid this space if possible as the heat is not properly conveyed across it by convection methods.

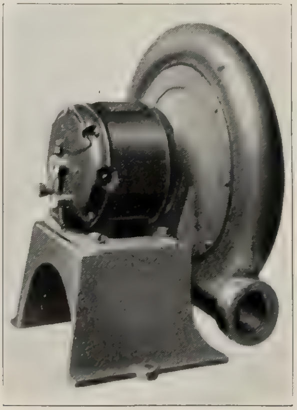


Figure 78—A Direct-connected Fan Blower

In a tubular blast burner (Figure 77) are provided several ports surrounded with a refractory material. Here the radiated heat causes the combustion to be brought about at an even higher rate than before. This in turn shortens the flame so that all factors combined give added speed and efficiency to the gas-burning system, together with the other results stated.

Fan blast is a desirable form of air pressure. At this point it seems especially desirable that some mention should be made of the fan-motor blowers generally employed with fan-blast burners.

Fan-motor Blowers (Figure 78) for use in the fan-blast system preferably should be direct connected and the base should be suitable for placing them against the wall. Thus the motor is out of the way and, if placed near a window, so much the better. The air pipe should be as free as possible of turns or bends and where these are essential they must be of long radius and as free from friction to the air as possible. No more than one bend or turn between the blower outlet and the burner should usually be required. The blower should be located in a cool place so that there is plenty of fresh air around it.

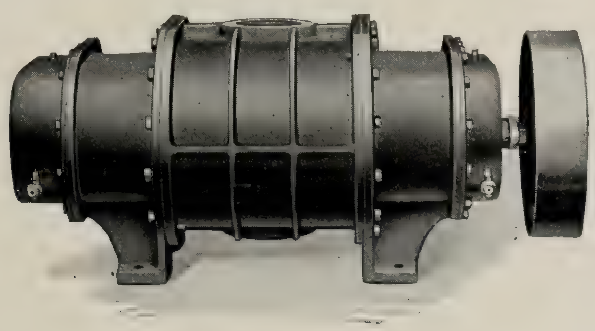


Figure 79—A Positive Pressure Pump

Positive Pressure Pumps (Figure 79) when added to especially designed atmospheric type burners increase the velocity of the gas, pumping it out of the gas main and transforming it into the higher velocity. The result is that the air is drawn into the mixer at a great velocity. All of this results in a hotter and more efficient gas flame.

This idea is used extensively in japanning ovens and enables the owner of such an installation to easily double the output of his burner over that of the atmospheric burner.

In Figure 80 is shown the cross-section of the two impellers, and their direction of rotation. The arrows indicate the flow of gas through the pump. These two impellers rotate on parallel shafts timed by a pair of accurately cut gears. The direction of rotation is clockwise when facing the driving end of the pump, with inlet through the lower opening and outlet at the top.

The action of the impellers, when moving the gas, is positive, for as each tip of each impeller passes the inlet opening it entraps a quantity of gas. An instant later the opposite tip of the same impeller is opening to the outlet, permitting the following lobe of the impeller to force the gas into the line. This is repeated four times for each revolution of the drives, giving a comparatively even flow of gas at the speeds recommended.

There is no contact between the impellers themselves or between them and the surrounding casing; consequently there is no friction requiring internal lubrication or seal.

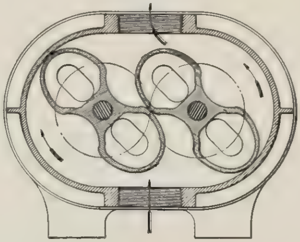


Figure 80—Cross-section of a Positive Pressure Pump

Natural Gas as well as artificial gas may be employed without any modifications in the burner construction unless the circumstances are very out of the ordinary. However, it must not be forgotten that natural gas generally contains a good deal more heat per cubic foot than artificial gas so that in many cases it may be possible to turn down the burners when natural gas is employed to a rather greater extent than when artificial gas is employed.

Here it is important to note that the heat in a gas is measured by a standard known as the *British thermal unit or B. t. u.* One B. t. u. is the heat required to raise the temperature of one pound of water 1 degree F. As an example, if we wanted to heat 10 pounds of water from 60 degrees F. to 160 degrees F. we would require one thousand (1,000) B. t. u.'s. We multiply the number of pounds of water by the number of degrees F. to which we are going to raise this water. Again: one thousand (1,000) pounds of water raised one degree F. from, for example, 60 degrees F. to 61 degrees F. would also require a thousand B. t. u.'s. City gas has an average thermal capacity of from 550 to 625 B. t. u.'s per cubic foot. Natural gas has around 800 to 1,000 B. t. u.'s per cubic foot or sometimes a little more. In the various burners described generally, the heat was practically all given off in the form of hot flames, but in the case of blast burners, part of the heat only is given off in the form of short flames, while the remainder is given off from a red hot refractory top.

When heat is conveyed from an ordinary burner to a pot or other substance it travels by *convection*. In other words, it travels along convected waves of hot flue gases, but when heat is conveyed from a hot bright body such as a red-hot bed of coke, a very large part of the heat is given off by *radiation*. Radiated heat is sometimes more desirable to use because it does not give up its heat until the actual solid body is reached. The sun gives its heat to the earth by radiation and it does not give up its heat until it actually strikes the earth or a body on the earth. On quite a cold frosty morning the sun might be shining brightly and yet the air can be below the freezing point, whereas if a person stands inside a room and allows the sun to fall upon him he will feel its heat, due to the fact that it has been received by radiation in place of by convection. Blast burner heads, when they become red hot, give their heat off in a very efficient manner, solely due to the fact that they give off radiation.

XV

BAKING OVENS

Gas Ovens (Direct Heat)
Gas Ovens (Indirect Heat)
Radiator-type Ovens
Convected Heat Ovens
Steam Ovens
Electric Ovens
Continuous Conveyor Ovens
Continuous Conveyor Ovens (A-type)
Special License Plates Oven
Installation of Ovens
Electric Heated Ovens

Gas Ovens (Direct Heat) (also called open flame) are now being used principally for baking low temperature materials. This type of oven requires more careful attention than the indirect type, since the volatile solvents give off inflammable vapors. If the circulation through the oven is not sufficient, these vapors may accumulate and may even be ignited thereby causing fires.

Temperature variations of even 10 degrees to 20 degrees sometimes cause a difference in the shade of the finished product. In a direct-heat oven the heat is unevenly distributed. A difference in shade will be observed by pieces in the same bake located in different parts of the oven. Those that are in a higher heat will be darker than those that are in a lower heat.

If a coating be underbaked it will be tacky or sticky to the touch. If overbaked it will chip easily and flake off. The gases from the gas-burner, of course, pass into the baking compartment and affect certain finishes.

The direct-heat or open-flame type of japanning oven is now prohibited by ordinances in most large cities, but in many of the smaller cities there are no ordinances covering the matter. Therefore, an attempt will be made to present the subject in such a way that officials of smaller cities will be able to see the need for passing safety ordinances covering the use of japanning ovens, particularly of the open-flame type (Figure 81).

This type of gas oven is used almost universally for japanning and will always be used where it is not feasible to use electricity, or some of the other types mentioned. Modern ovens are always sectional, which means that they are portable.

Gas Ovens (Indirect Heat) have almost entirely replaced open-flame ovens on account of their many advantages in the way of safety, economy, speed, and the ease with which the baking heats are both obtained and controlled. The danger of damaging the work by dirt is reduced to a minimum and work can be turned out in a given time. Nearly every make of japan has its own time baking temperature. In an indirect gas oven the temperature is under control and any degree of heat required for the work may be maintained.

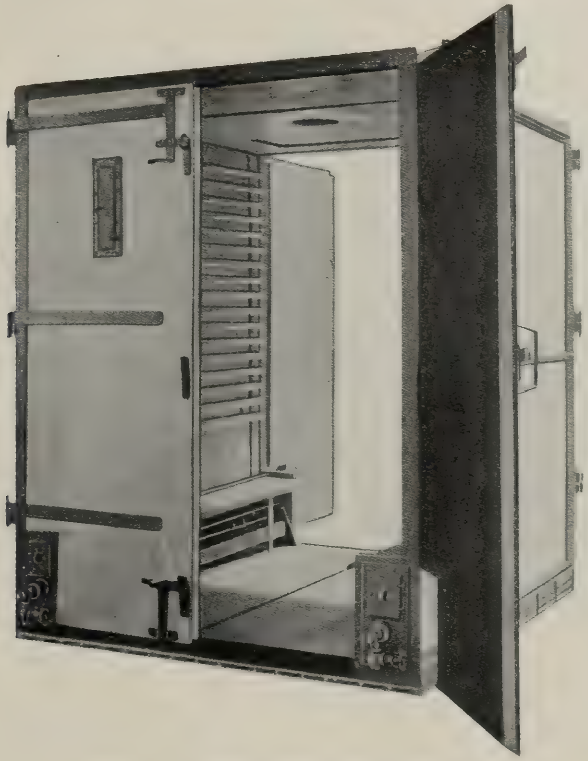


Figure 81—Direct-heat Open-flame Oven

In the indirect oven the flue gases are confined inside a separate compartment that is independent of the baking compartment. The indirect type of oven (Figure 82) consists of an outside shell insulated with some non-conductor of heat. The oven is heated from burners located under the bottom plate.

When the indirect-fired oven is used many difficulties are overcome. The baking compartment contains only hot, dry air which acts on the japan solvents and carries them off through the vent from the oven. This also allows the chemical reaction to progress without interference to produce a perfect surface.

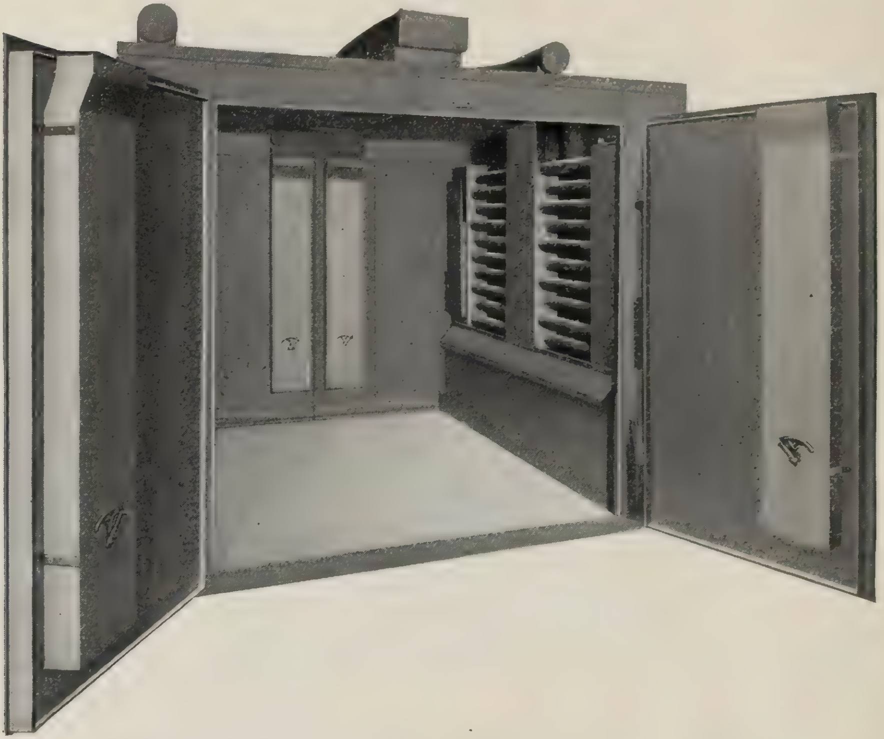


Figure 82—PULL THROUGH OVEN (DOUBLE DOORS FRONT AND REAR) INDIRECT GAS HEAT

In indirect-type ovens, the burners are entirely enclosed in a separate chamber which is independent of the wall construction, thus preventing the gas fumes, and so forth, from entering the baking compartment. The chambers are connected with ducts by a series of flues or radiators.

These radiators are completely within the baking compartment and the direct heat from the burner chamber while passing through them on its way to the upper ducts, radiates from the entire surface.

of each flue, thus utilizing much of the radiated heat for the baking compartment (Figure 83).

Radiator-type Ovens cover that class of indirect-fired oven in which fresh air is heated as it passes over heated radiators. The oven is so constructed as to supply constantly the baking compartment with preheated fresh air free of products of combustion from the burning gas. The heat is made to travel all along the flues and is then collected in a central flue connected to the open air.

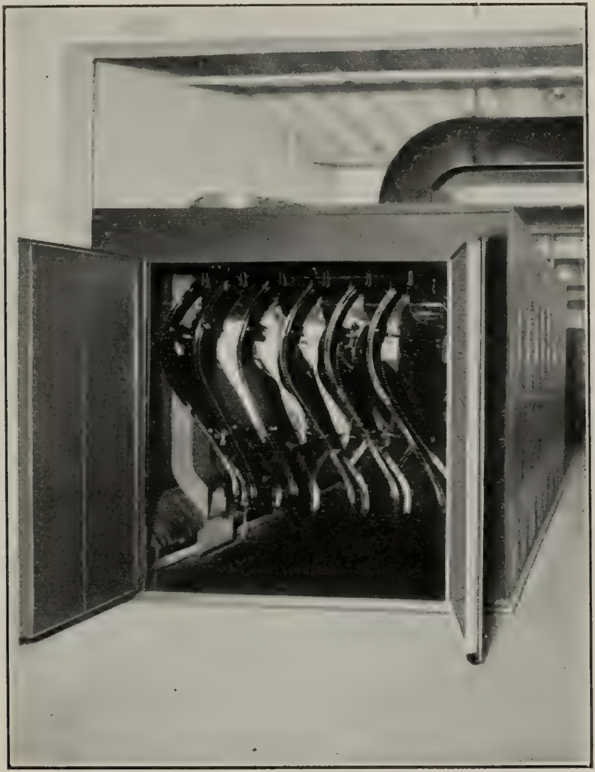


Figure 83—An Oven-load of Fenders

Convected Heat Ovens are a new development in heating. By convection is meant the diffusion of heat through a liquid or gas medium by motion of its parts. In this case the heat generating unit employed is a direct-fired indirect type of power plant, known as the air-tube heater, and consists essentially of a fire-brick arch and combustion chamber in which a heavy grade of fuel oil is burned. Above the combustion chamber is arranged a series of tubes, over which the hot products of combustion pass, in a similar manner to that of a water-tube boiler. The air to be heated is passed through the *inside* of the tubes.

The heated air is delivered to the oven by means of a fan system in accordance with the laws governing the transmission of heat by convection. The uniform distribution of the heated air in the oven is accomplished by means of a special equalizing distributor duct which secures an even and uniform supply of heat to all parts of the oven, in the case of the compartment type of oven. By varying its proportions, any desired gradation of temperature in the continuous automatic type of oven may be obtained.

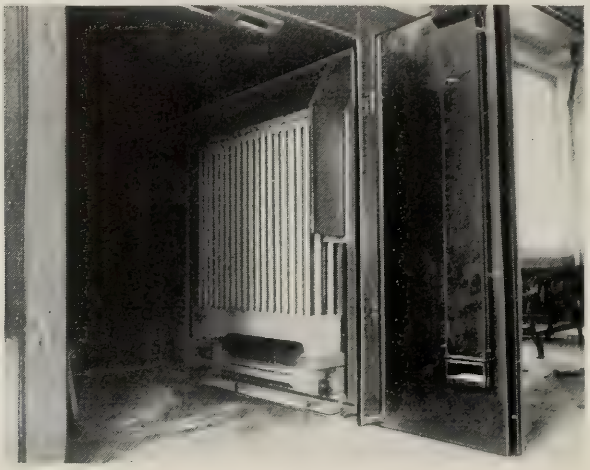


Figure 84—Steam Heater—Shown without Shield

Provision may be made in this system for washing the air before heating, in order to remove the microscopic dust and dirt that it may carry and also for the addition of water vapor in such quantity above that carried by normal atmospheric air as to insure the best results. This latter feature is useful in baking any coating material containing varnish made of a drying oil.

Steam Ovens (Figure 84) while not used as extensively as the gas and electric type are used to a certain extent. It is customary to cover the heating units with shields, but the illustration herewith shows the shield removed.

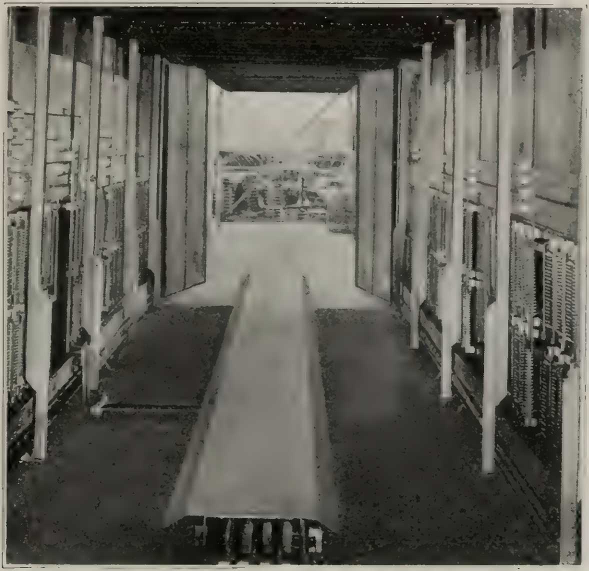


Figure 85—An Electric-heated Intermittent Conveyor Oven

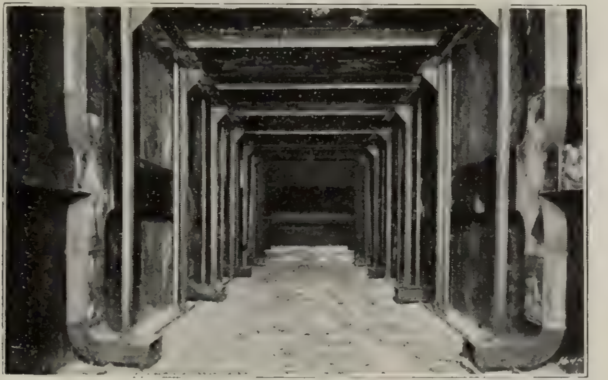


Figure 86—Taking the Fumes Away

Electric Ovens (Figure 85) are not a great deal different from indirect gas ovens except that more room is made available.

Continuous Conveyor Ovens (Color Plate II), as the name indicates, provide a continuous system of finishing.

The parts are hung on the loading end of the conveyor and, once in position, are carried through the entire process and finally reach the end of the system where they are unloaded. The conveyor chain, of course, continues back to the loading position over the tops of the various ovens.

In a continuous conveyor oven installation there are a number of important details to be considered and one of them is the matter of taking the fumes away as indicated in Figure 86.

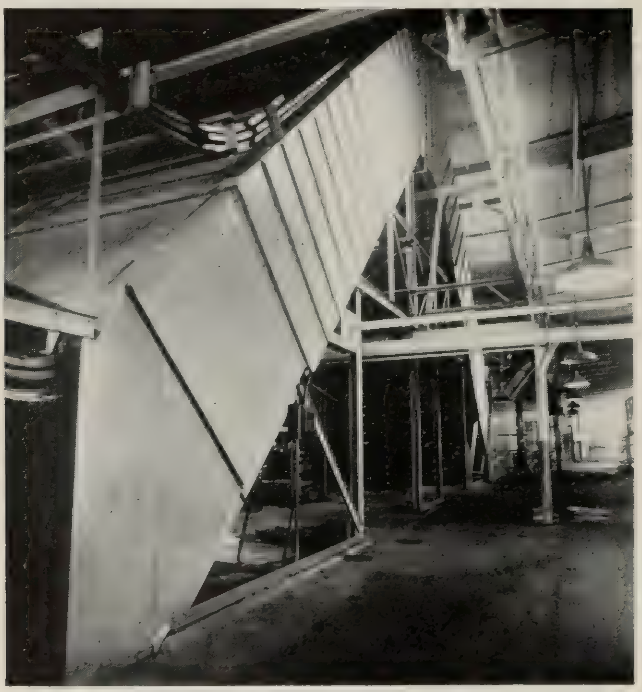
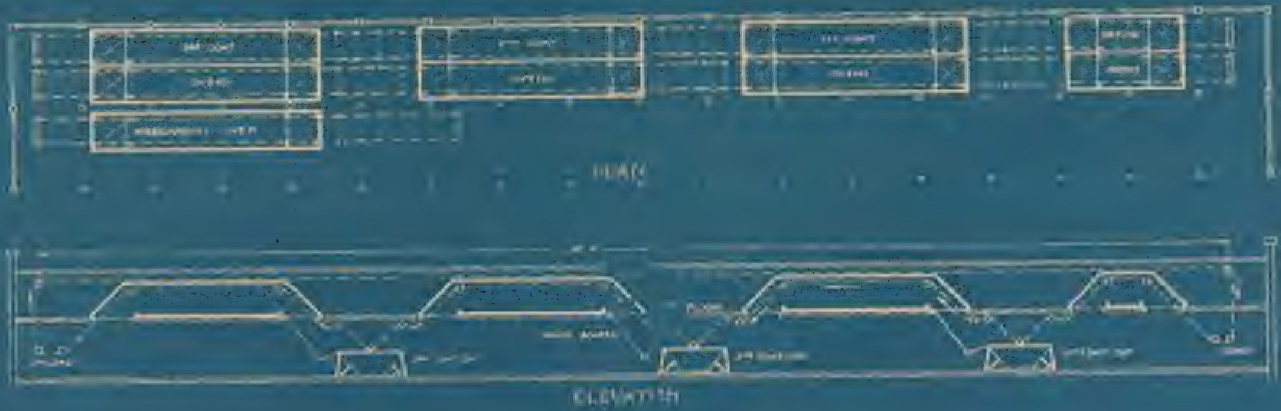


Figure 87—A-type Continuous Conveyor Japanning Oven

Continuous Conveyor Ovens (A-type) (Figure 87), so-called because they are shaped like the letter A, are the result of experience in operation and design and are said to be the last word in so far as efficiency is concerned.



Color Plate II.—A General Layout for Japanning Sheet Metal Parts

The curves shown in Figure 88 explain more than words could just why this is. Here we have the picture at a glance. Please note that the two curves are also *A-type* and that the hottest point or peak is reached at the top or apex of each oven unit. In other words, as the temperature decreases the location of the work on the conveyor approaches closer and closer to the oven's ends. Please note also that the shape of the ends of the oven unit *pockets* the hot air inside the oven so that it cannot escape. Thus all the *useful heat* that it is possible to secure out of a certain heat application is obtained.

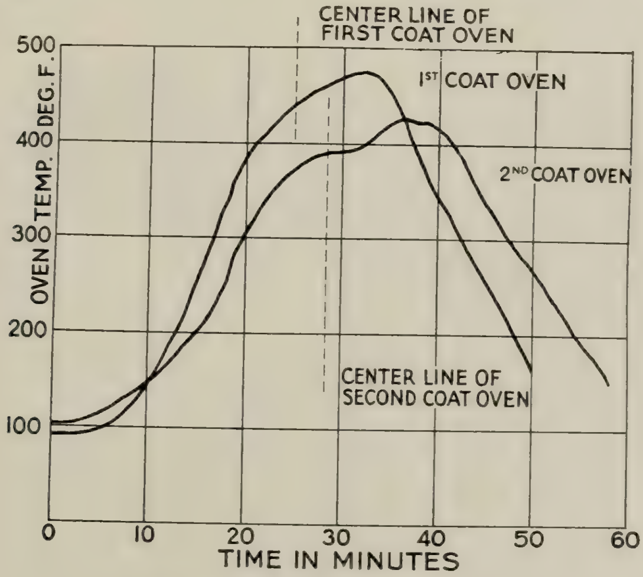


Figure 88—A-type Oven Heating Curves

Two of these A-units placed in series and connected by a common continuous conveyor moving at the rate of 16 inches per minute have a capacity of approximately 140 tons of two-coated japan per day. It should be stated that the double-unit, one of which is illustrated here, is approximately 200 feet long. Its two dip tanks have a capacity of five thousand (5,000) gallons each and are equipped with continuous clarifiers. Inside the average cross-sectional area is eight feet high and nine feet wide.

It is highly desirable, of course, that an installation the size of this be practically independent of weather conditions, and that the air introduced to the baking department be closely controlled as to temperature and purity. To meet this requirement, the air is supplied by power-driven fans which force it first through steam coils, where it is brought to a predetermined temperature, and then passed through reed filters, where dust and other impurities are removed.

The air supply from the filters enters the oven room under pressure at three separate receiving points; the loading end, the unloading end, and in the space between the two ovens. A special arrangement of ventilating ducts in the ovens, and control of the air at the three receiving points, determine the direction of flow within the ovens which is, of course, counter to the direction of the work.

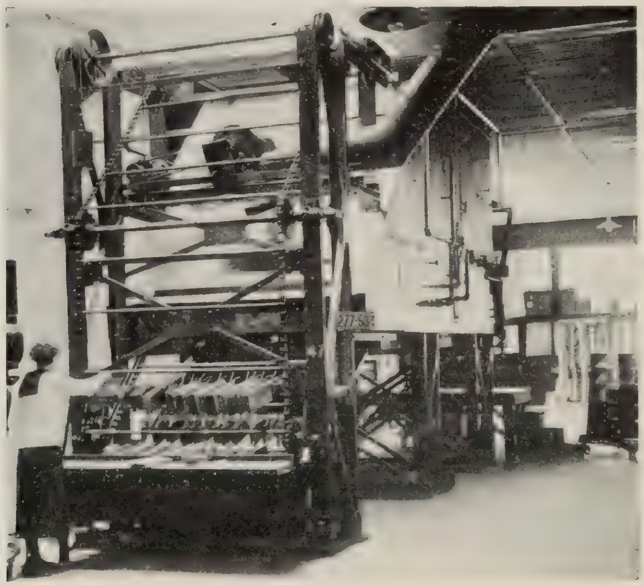


Figure 89—Finishing Automobile License Plates

This allows an interchange of heat between the air and the work and subsequently reduces the amount of power required. It also reduces the volume of smoke and fumes in the ovens. The result is the elimination of condensation within the ovens, very fine baking conditions and a great degree of safety.

Special License Plates Ovens. License plates are sometimes finished with a continuous conveyor (Figure 89). Also, the use of female labor is another element considered in cutting costs of production. The high lights, as the trade terms the second color, are applied by means of a coating machine such as that shown in Figure 62, page 131.

Installation of Ovens if properly done will eliminate many hazards. Ovens should not be set close (not less than 10 inches) to a lath and plaster, or other combustible wall. The floor should be covered with some non-conducting fire-proof material. Usually a one-quarter-inch to two-inch layer of insulation covered by sheet metal can be installed at small expense and without making an unsightly appearance.

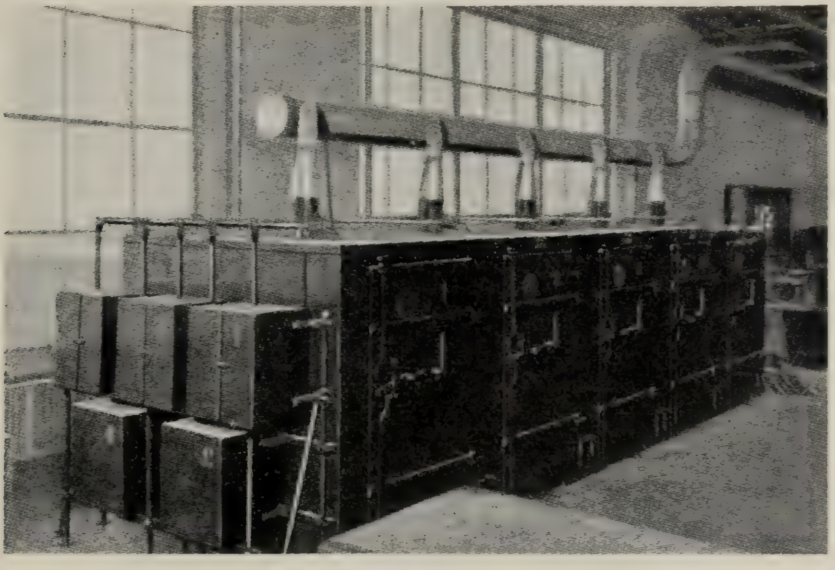


Figure 90—A Battery of Five Electrically-heated Ovens

The use of a suitable flue connection is recommended. The larger the amount of gas burned, the larger is the volume of combustion products given off and the greater the advisability of carrying them off. It is especially important that the outlet from the oven for the escape of products of combustion never be closed, for if a free escape is not provided, the flames will be smothered and then unburned gas will escape with consequent danger of explosion, or asphyxiation. Some have an idea that closing the vent opening in the early period of baking will save heat, but this is not true. It only serves to produce a very dangerous condition.

Electric Heated Ovens aside from their heating feature are adapted to compact and flexible installation. Here (Figure 90), for example, all of the electric controlling devices are located on the left end of the battery and take up very little room.

XVI

LOADING THE OVEN

The Hand Method
The Truck Method
The Trolley Method
The Spray-oven-monorail System
The Intermittent Conveyor
The Continuous Draw-chain Method
The Continuous Conveyor
Car Conveyors
A Trolley Conveyor
Two-bake Continuous Conveyor Ovens
Combination Spray and Conveyor Ovens
Heavy Swinging Carriers
Lift Racks

The Hand Method involves loading the ovens by carrying the material to the oven and hanging it on bars which are placed on special supports. The operator carries the work into the oven, taking a few pieces at a time. It is necessary that the oven be cold, as a workman cannot enter or hand load an oven that is hot.

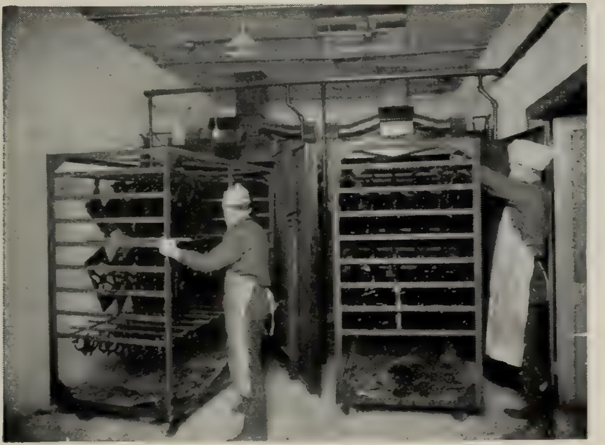


Figure 91—Oven Truck

The Truck Method is a step in advance over the hand method. The japanner has the truck (Figure 91) close to him and places the material on it as he coats the articles. When the truck is loaded he pushes it into the oven, sets the oven in operation and proceeds to load a second truck. When the first truck has been in the oven the required length of time it is pulled out and the second truck pushed in its place. Therefore, it is not necessary for the oven to be cold for loading and unloading where this method is employed. This increases production and saves heat and labor. A battery of baking ovens for automobile bodies on individual trucks is shown in Figure 92.

THE TROLLEY METHOD of loading the oven (Figure 93) consists of placing the parts on a special truck suspended from an overhead trolley. This method has the advantage of reducing the vibration of the parts to a minimum, since the whole load can be pushed by one man from the loading department to the oven *before* baking and to the next department into which the trolley leads *after* baking. This oven has a gas consumption of 1,000 cubic feet per hour. Its size is 8 feet by 20 feet by 9 feet and it weighs ten thousand (10,000) pounds.

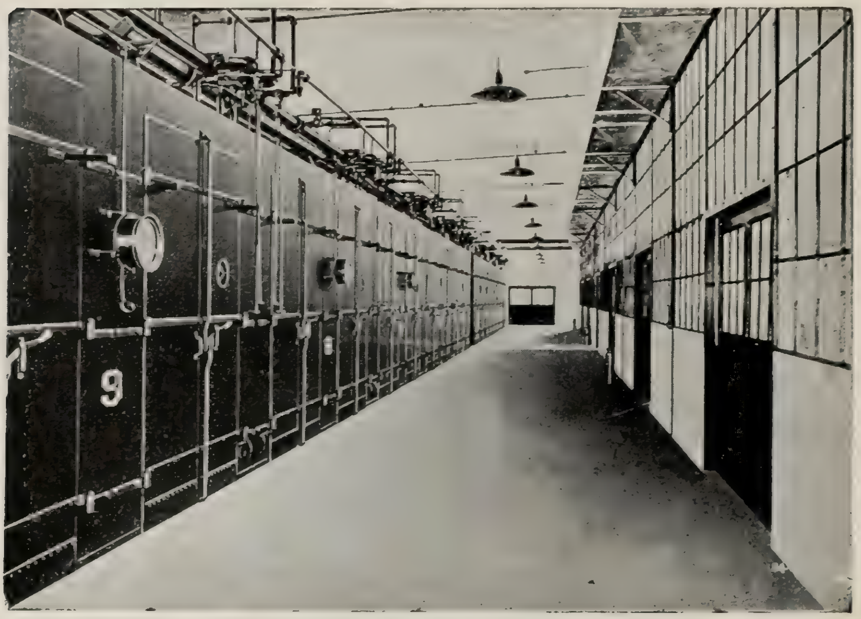


Figure 92—BATTERY OF OVENS

THE SPRAY-OVEN-MONORAIL SYSTEM is often used when the product is of one kind. In the finishing of small automobile bodies, for

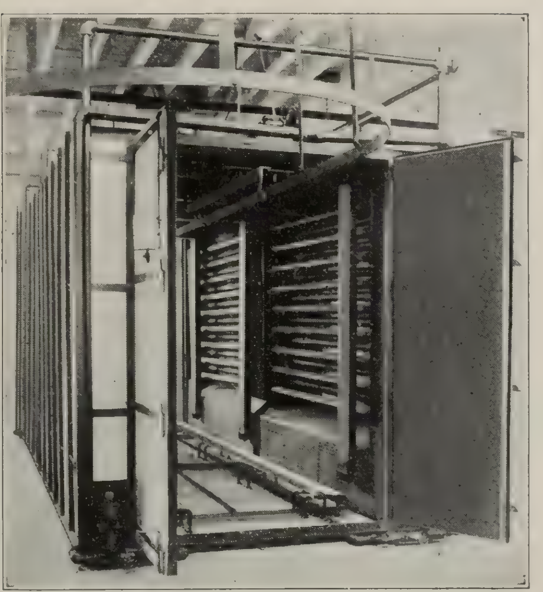


Figure 93—Combination Japanning and Tempering Oven

example (Figure 94), special fixtures are built so that the bodies may be turned at will and sprayed, after which the carrying truck

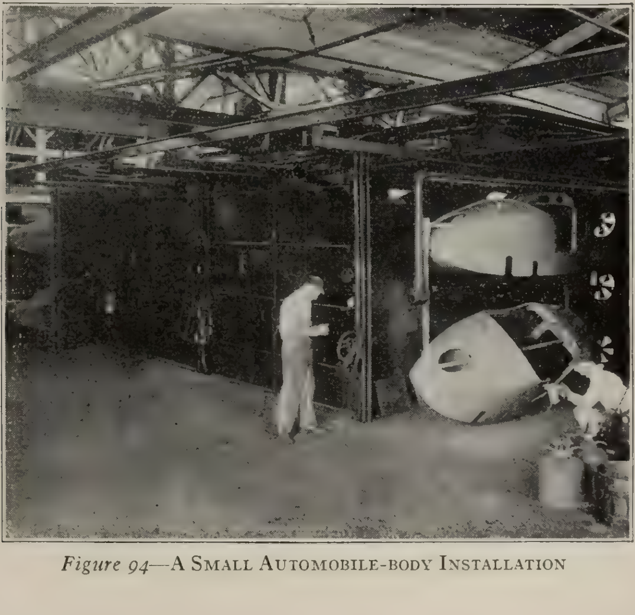


Figure 94—A Small Automobile-body Installation

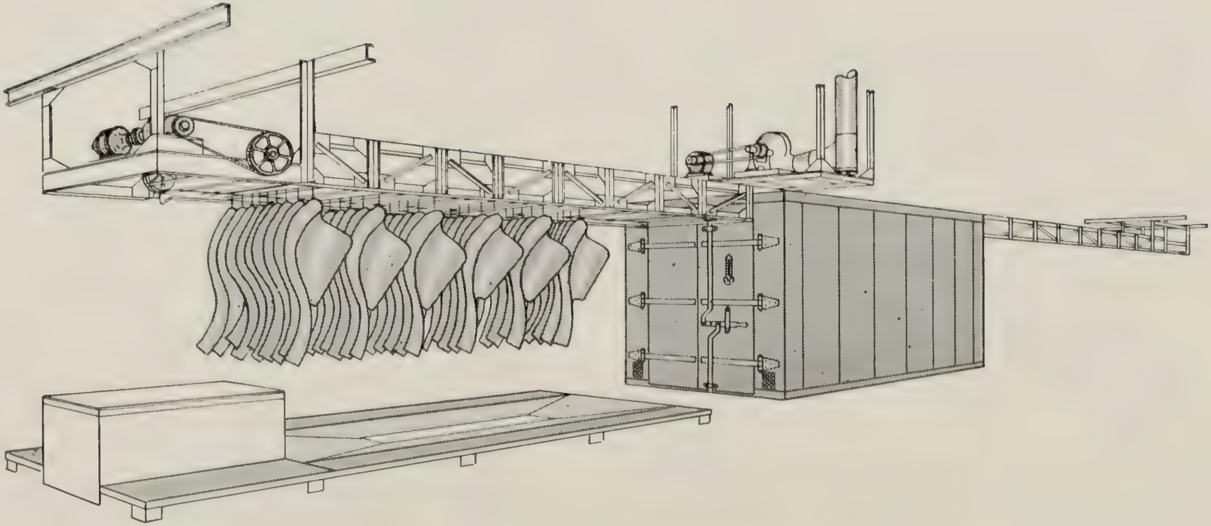


Figure 95—PERSPECTIVE OF INTERMITTENT CONVEYOR

is pushed out of the spray booth along the overhead monorail and finally into the baking oven.

The Intermittent Conveyor (Figure 95) requires hanging the metal parts as they are coated or dipped by hand on a section of the conveyor that is over a drain board. This section (or block of work) moves forward into the oven when the conveyor is operated, thus loading the oven quickly. Next, the front and rear doors of the oven are closed. After baking, which takes approximately one hour, the conveyor is operated once more to carry the baked parts out of the oven or to the third position, where they are allowed to cool and be packed for shipment. In other words, the work occupies successive positions along the conveyor structure—draining, baking, and cooling. The return path of the conveyor is over the oven. Empty spaces must be left on the conveyor front and rear for the oven doors to clear. Automatic lift doors close the slot

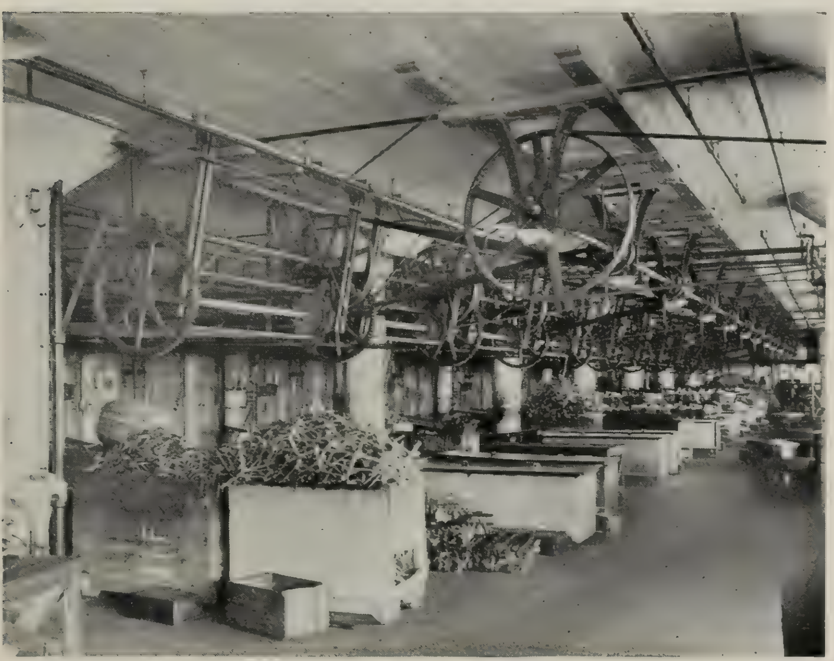


Figure 96—A Battery of Intermittent Conveyor Ovens

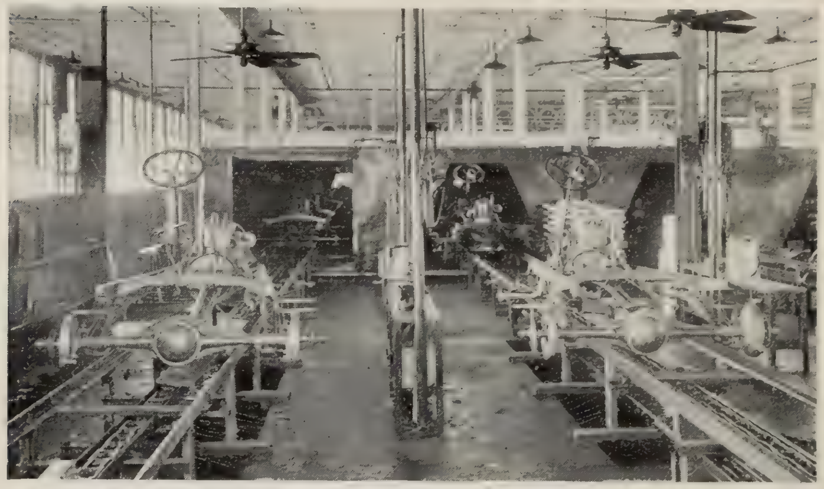


Figure 97—A Continuous Chassis Installation (Entrance End)

through which the conveyor passes, thus preventing the escape of the fumes at this point while the oven is being heated.

A part of one battery of conveyor ovens (Figure 96) occupied a space 220 feet long. As two or more coats are usually required similar units are usually installed in pairs, side by side.

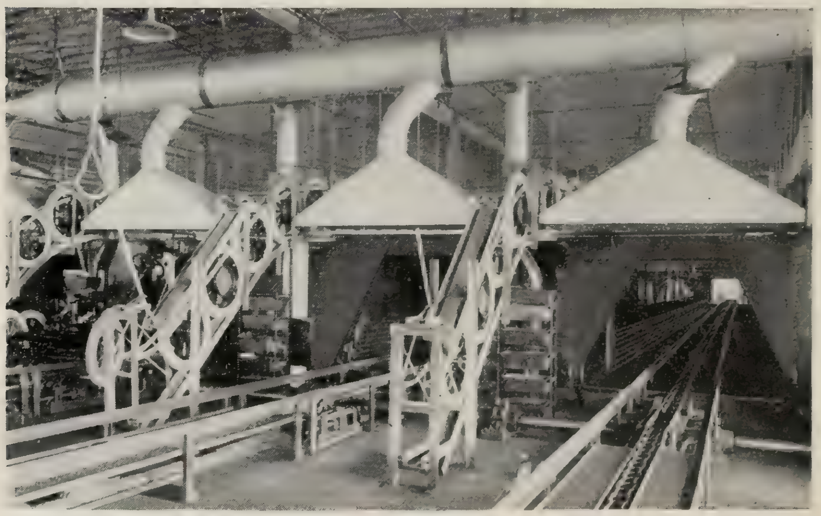


Figure 98—A Continuous Chassis Installation (Exit End)

The alternate conveyors move in opposite directions, hence the drain board for the first coat is beside the cooling position for the second coat, and so forth. The duplex outfit (two conveyor units) of the above type will readily handle the two-coat japan finish on all the sheet-metal parts needed for a production of 200 autos per day. This output is secured by a baking cycle of one hour or less with a temperature of, say, 450 degrees F. for black japan.

The Continuous Draw-chain Method is illustrated in Figure 97. This shows an automobile chassis being slowly propelled by a continuous draw chain. The chassis (in the foreground) has just been sprayed with chassis black. This painting operation is done over a floor-type exhaust which takes away the fumes. The entire painting operation here takes one spray operator four minutes.

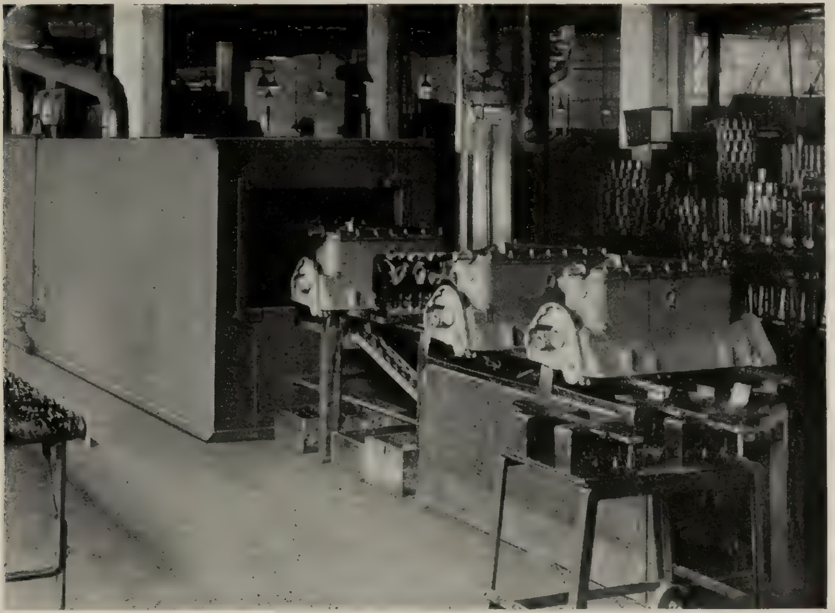


Figure 99—A Continuous Draw-chain Oven for Automobile Engines

The exit end of the chassis oven (Figure 98) is shown in conjunction with wheel conveyors which are located between the oven units to save floor space. It should be noted that the next operation after the paint on the chassis has dried is the assembling of the wheels.

Figure 99 shows an installation for baking the finish on automobile engines. They are simply placed on the continuously moving draw-chain conveyor which carries them through the baking oven.

The Continuous Conveyor Method is the fastest and cheapest from the standpoint of labor cost. The parts simply are hung on the moving chain which carries them from one operation to another without interruption.

Parts, for example, are loaded on the conveyor, and travel into the first unit which in this case is a bake-out oven to drive off the oils from the metal surface. The parts cool to approximately room temperature before they are carried into the first coat dip. From this dip (Figure 100) they pass to the drain boards and then into the first coat oven. The cycle of dip, drain, bake and cool, is of course, repeated for the second and even the third coat of japan. After a travel of considerably over 300 feet the finished parts are finally removed from the conveyor.

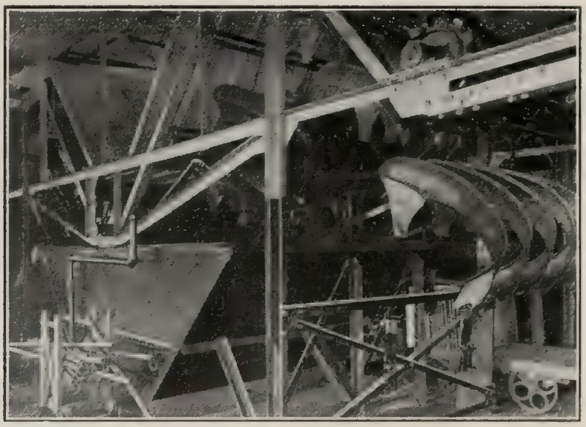


Figure 100—A Continuous Conveyor Oven in Operation

The parts to be coated are hung from cross members joining the parallel chains of the conveyor. Electric heaters are grouped on the side walls and the floor and the temperature control for each oven is automatic. Positive ventilation is maintained by motor-driven fans. An extra oven is used for miscellaneous parts which require an extra coat, or anything less than the three coats baked on the main conveyor.

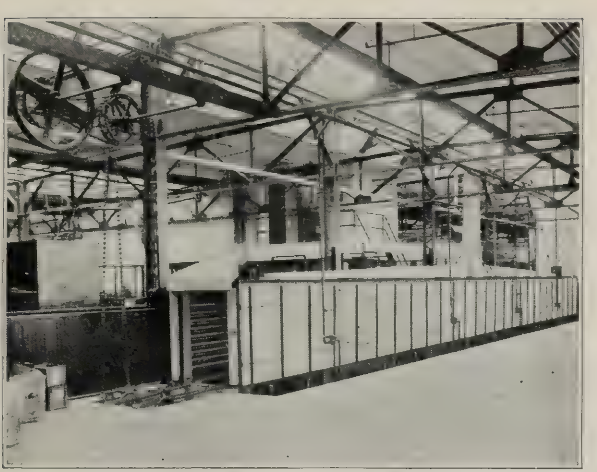


Figure 101—A Floor-type Continuous Conveyor Oven

A special continuous floor-type conveyor equipment for baking enamel on electric washing machines is shown in Figure 101. The machines pass through this oven and are baked at the rate of 25 per hour. This installation is equipped with four sets of automatic temperature controllers.

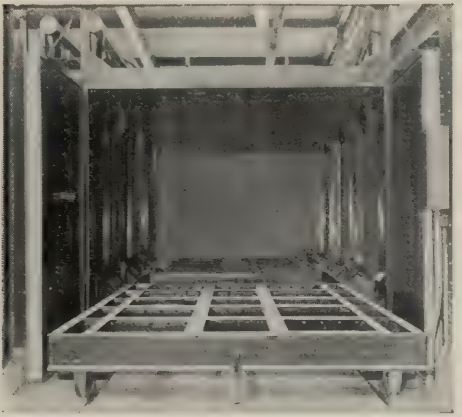


Figure 102—A Car Conveyor

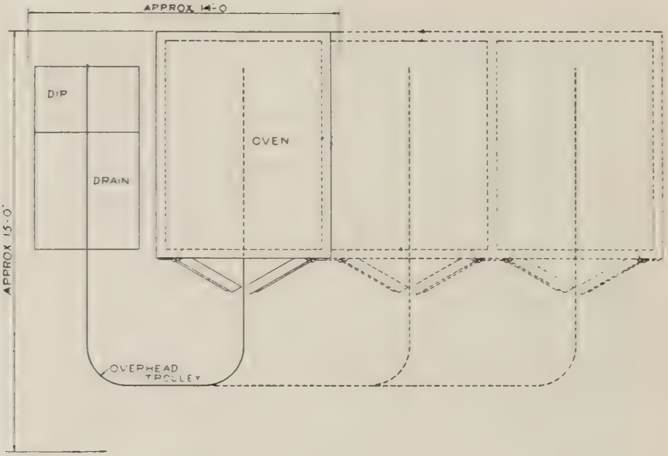


Figure 103—A Trolley Layout

Car Conveyors (Figure 102) find an application now and then. They are strong and heavy and whatever load is put on them may be pulled or pushed out of the oven as one unit.

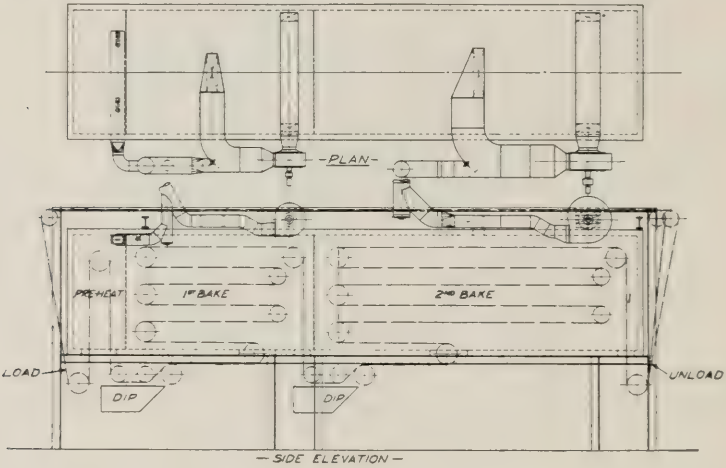


Figure 104—Two-bake Compartment Conveyor Oven

A Trolley Conveyor[1] (Figure 103) is often used where a compact installation is needed. Here the dip and drain are located alongside the ovens and out of the way.

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[1] Compare this with that shown in Figure 94, page 175.

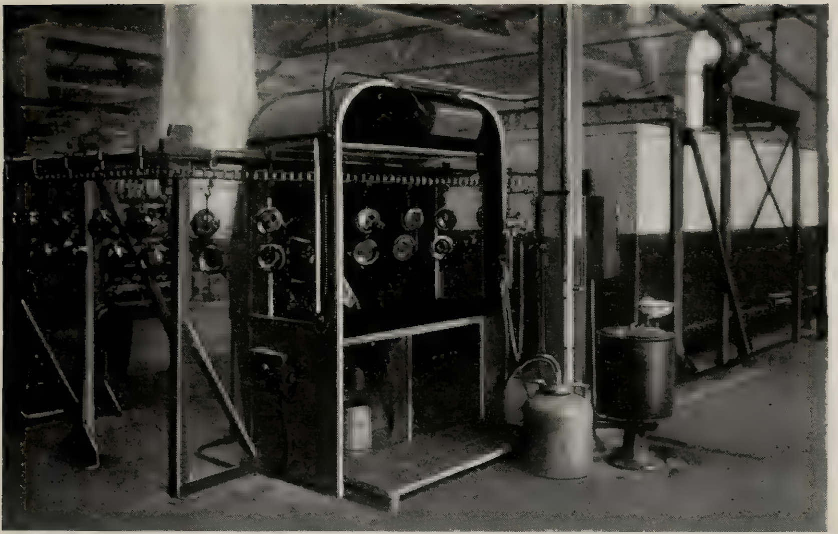

Figure 105—Combination Spray and Oven Installation

Two-bake Continuous Conveyor Ovens (Figure 104) have a special application now and then. Note that there is a clear floor space beneath this oven since the entire structure is elevated to provide space for the two dips.

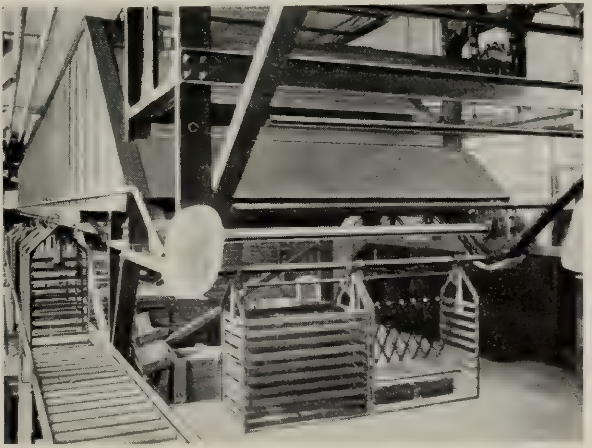

Figure 106—A Heavy Carrier

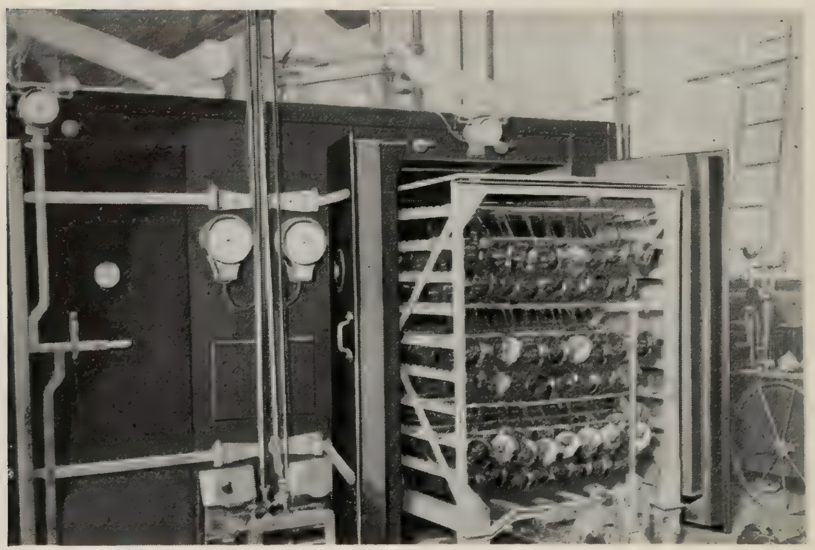

Figure 107—Using Lift Racks

Combination Spray and Conveyor Ovens, the type of installation illustrated herewith (Figure 105), offer a suggestion of the possibility of reducing labor to a minimum. This equipment is in use in one of the largest electrical plants in the country. Two men take care of the entire outfit; one to load and unload, and the other to spray the work as it passes in front of him.

Heavy Swinging Carriers (Figure 106) have been designed to especially fit the heavy cross-bars of the conveyor into which the parts to be japanned are placed. These racks are returned to the loading end of the oven on the gravity roller conveyor shown.

Lift Racks (Figure 107) are not overlooked in the various methods of handling work in and out of japanning ovens. Since the use of floor roller trucks has been changing gradually to this type of handling, it is natural that its use should find an extensive use in japanning and enameling problems.

XVII

ACCESSORY EQUIPMENT

Hand Rubbing
Mechanical Rubbing
Polishing
Gas-meters
Reading Meters
Errors of Gas-meters
Operating Costs
Dial Thermometers
Angle Thermometers
Recording Thermometers
An Automatic Temperature Controller
Time Indicators
Fans or Blowers
Automatic Cut-offs
Proportional Mixers
Premixing Machines
Ventilators
The Viscosity Cup
The Hydrometer

Hand Rubbing a japan-coated surface with water and finally with ground pumice takes the place of sandpaper. After the rubbing operation is completed the article should be baked for half an hour to draw off any moisture that may have been forced into the surface by the rubbing operation, otherwise it will be impossible to get a clean finishing coat on properly.

To the japanner, not well experienced at rubbing, a guide coat is recommended. This should be applied to the surface before rubbing to guide the operator in not getting too deep, or not deep enough. A formula for the guide coat is as follows:

1. A few drops of linseed oil
2. A small amount of burnt umber in oil
3. Enough turpentine to make a thin coating

By far the best hand-rubbing felt is made from the *used* felt coverings of the rollers in paper mills, if it can be obtained. It is preferred because it has been pounded and packed together—especially prepared by a process that could not be introduced in its manufacture, on account of the cost. After obtaining a piece of this felt soak it in water for 24 hours and then roll it tightly until a roll is produced about four inches high and four inches in diameter. Drive carpet tacks into the outer end to hold it securely. Keep the surface thoroughly soaked with water, otherwise it is likely to be scratched easily.

Powdered pumice stone (fine) should be used. It may be obtained in any drug or paint store. Number 0 steel wool is often used where the job is not particular and where cheapness is paramount.

Another rubbing method is used in some japan shops. It cuts the cost of the former considerably. A very fine grade of water-proof sandpaper[1] is used to touch-up the surface in spots. After this the parts are washed with a large sponge, perfectly free from grit. This dirty water in the sponge is squeezed out before the sponge is again dipped in a large pail containing the following solution, which must be agitated freely to keep it mixed. This is done by raising and lowering the sponge in the solution:

18 quarts of clean water
6 quarts benzine
1 tablespoonful of imported olive oil

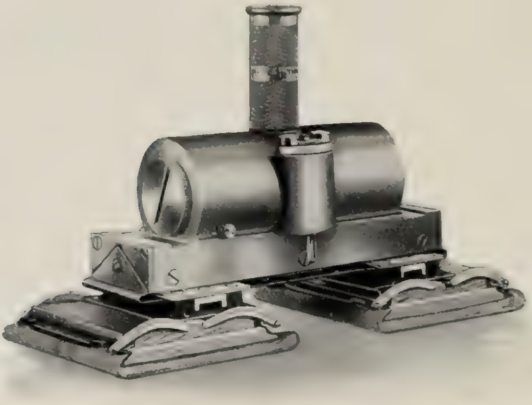

Figure 108—Rubbing Machine with Sandpaper Attachments

Mechanical Rubbing has been the dream of many japanners, but up to the present time it has not been extensively used. There is no doubt that in the near future the use of mechanical rubbing will be extended and that it will be either an electrical or an air-operated tool, such as is now used so successfully on flat surfaces. There is no doubt about the use of a rubbing machine right now—if the japanner has flat surfaces to be rubbed.

The rubbing machine is placed lengthwise on the work, then brought crosswise to and from the operator, which will keep the water and pumice between the felts and prevent the finishing material from being picked up.

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[1] See *Practical Automotive Lacquering*, Volume II, Chapter VII.

Pressure may be put on the machine the first few times across, according to the amount of stock to be cut down. On the finishing strokes the machine should be allowed to pass over the work lengthwise under its own weight and pressure. Two different sets of felts are usually furnished with each machine; one which will be found to cut very rapidly, and one thick soft felt. The quality of the work turned out is very high grade, a much more uniform surface being produced by the use of machine than when rubbing by hand.

This machine may also be equipped with a sandpaper attachment (Figure 108); but the practical use of such an arrangement is as yet limited to flat panels.

A compressed-air rubbing machine ordinarily requires about 15 cubic feet of free air per minute. It does superior work and there is about a 25% saving in the net production cost. The saving in labor is great—about 50%—but the interest on the investment, cost of maintenance and use of power brings the net saving down. The following fundamentals are necessary in order to make the rubbing machine a complete success in the japanning business:

1. Short stroke to permit working on a small surface.
2. The machine must permit use of same materials that are now used in hand rubbing.
3. The reciprocating action of the two rubbers must reduce vibration and reaction to a minimum.
4. The machine must be correctly weighted or loaded so as not to permit the attachments to gouge the varnish or japan on account of too much weight.

Polishing is done with powdered rotten stone and rubbing oil. This produces a brilliant rubbed effect. For best results strokes should be made in one direction only. The most satisfactory results are now obtained by hand polishing in which the workman actually uses his *bare hand* to bring out the bright surface. (The reader is likely to interpret the term *hand* to mean the opposite of mechanical but the *hand of the workman* is correct.)

Gas-meters are commonly used in the United States and in parts of Europe for the measuring of gas on the shop premises. Dry gas being the principal form of heat energy used by japanners, should be more thoroughly understood.

There are a number of different types of dry-gas meters in use, which, while differing considerably in external appearance and design of parts, operate similarly. The general principles of operation would be understood from a description of one of the types. Therefore the one most commonly used will be described.

The external appearance of the meter (Figure 109) is, of course, familiar. The interior (Figure 110) with the front and top of the meter and the top of the valve chamber removed, is not so familiar. The meter consists of four chambers, which are filled and emptied of gas by the action of the meter mechanism. The number of times this filling and emptying of the measuring chambers is repeated is indicated on the dial in cubic feet. Two of the measuring chambers

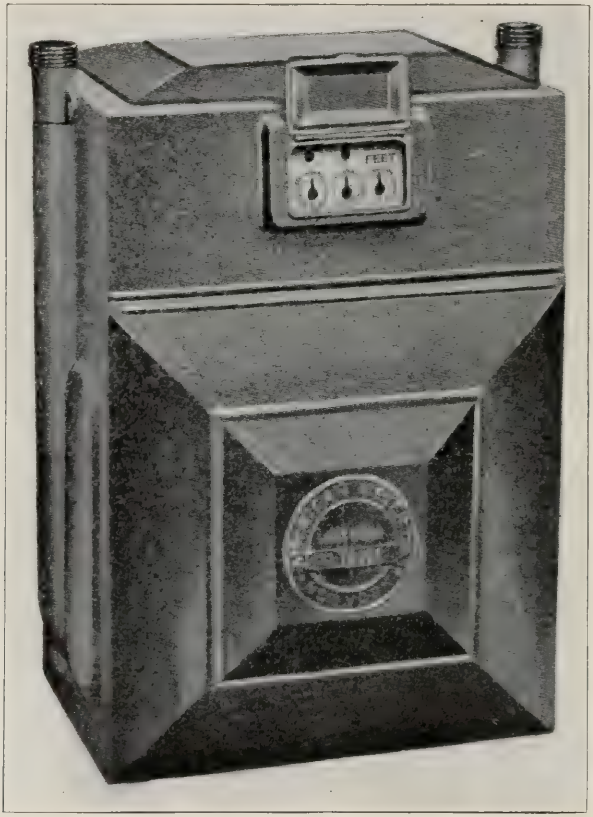

Figure 109—GAS-METER (EXTERIOR)

are shown in the figure. One is the space between the disk (a) with attached leather diaphragm (b) and the middle partition (the plate just behind the diaphragm) of the meter. The other is the space between this same disk and diaphragm and the outside walls of the meter.

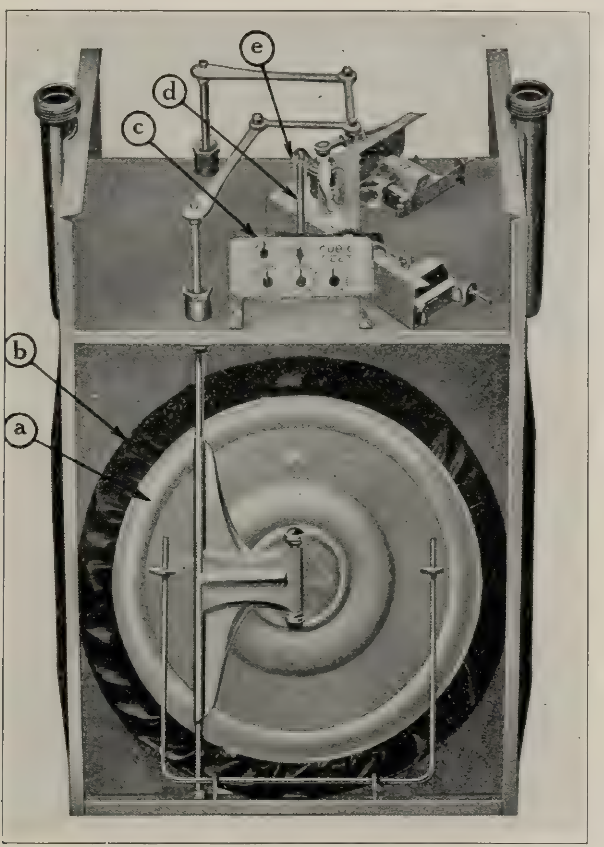

Figure 110—Gas-meter (Interior)

The other two measuring chambers are like the two described, and are situated symmetrically to them on the opposite side of the middle partition. The filling and emptying of the measuring chambers is effected by the backward and forward movement of the disks. These disks operate in conjunction with the valves and recording mechanism above the measuring chambers. Each set of two measuring chambers thus constitutes a kind of double-action bellows, the number of times these are filled and emptied being a measure of the amount of gas passed through them.

The power for operating this very simple and effective instrument is furnished by the pressure of the gas itself which acts upon the disks, pushing them back and forth, just as the power to operate the steam engine is furnished by the steam which presses upon the sides of the piston. The index (c) upon which the volume of gas passes is recorded is connected to the other mechanism by means of the shaft (d) and gear wheel (e).

Reading Meters is a simple task after one has had a little practice. The index of an ordinary gas-meter (Figure 111) is similar to that of an electric meter. Each dial is marked with the volume of gas passed per revolution. The smaller top dial, which is marked "Two Feet" inside of the circle, is generally called the *testing circle* or *proving head,* and is used principally in testing the meter. One revolution of the hand of the testing circle indicates that two cubic feet of gas have passed through the meter. In some meters one revolution of the hand of the testing circle represents more or less than two cubic feet of gas and the testing circles are correspondingly marked. The indication of the hand of the testing circle is ignored in the ordinary reading of the meter.

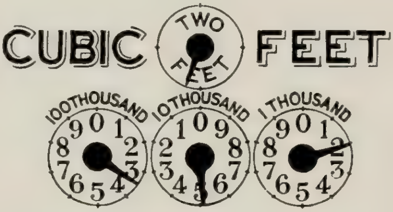

Figure 111—The Index of a Gas-meter

Of the large dials the first one at the right is usually marked "one thousand." This means that during one complete revolution of the hand one thousand cubic feet of gas has passed through the meter. This dial is divided into 10 equal parts so that the passage of the hand over each part indicates the passage of one-tenth of 1,000 cubic feet or 100 cubic feet. For most meters, it may be said of other dials that the complete revolution of each hand indicates the passage of ten times as much gas as one revolution of the hand of the dial of next lower denomination (usually the one to the right). The figure representing the number of cubic feet discharging during one revolution of the hand is written over each dial. Thus if the right dial be marked "1 thousand," the next dial will be marked "10 thousand," the left one "100 thousand."

The reading of the index in Figure 111 is as follows:

1 thousand dial	200 cubic feet
10 thousand dial	5000 cubic feet
100 thousand dial	30000 cubic feet
Complete reading of meter	35200 cubic feet

It is not necessary to write down separately the reading of each dial, but it is much shorter to set down from right to left the figure *last passed* by the hand of each dial, commencing with the dial of lowest denomination and then—if the dial of lowest denomination is marked "1 thousand"—add two zeros to the resulting figures.

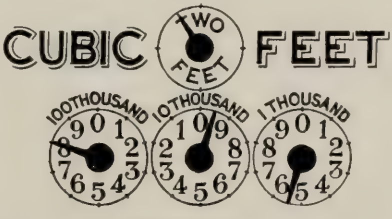

Figure 112—GAS-METER READING 79,500 CUBIC FEET

To illustrate further the method of reading meters, cuts of another setting (Figure 112) of a meter index is given. If a hand be very nearly over one of the figures on a dial, it will be impossible to tell without consulting the dial of the next lower denomination whether the figure under the hand or that just previously passed by the hand should be read. For example, the hand of the "100 thousand" dial is over eight and considering this dial alone the reading might be taken as eight; but, it is seen that the reading of the "100 thousand" dial cannot have reached eight, since the head of the "10 thousand" dial has not reached zero. The reading of the "100 thousand" dial is therefore seven and the correct reading of the entire index is 79,500 cubic feet.

ERRORS OF GAS-METERS should be known by the japanner. When a meter registers more gas than is actually passed, it is said to be *fast,* and the bill will therefore be too large. When a meter registers less gas than is actually passed, it is said to be *slow* and the bill will be too small. Gas companies are permitted to have meters in operation which are fast or slow by not more than a definite small amount.

This allowed variation from absolute accuracy is called a *tolerance* and usually varies from 1% to 3%. If meters are as often slow as fast, neither producer nor consumer ultimately loses any large amount.

To be sure that the gas company does not make mistakes in reading the meter, it is well for the consumer to occasionally read his meter at as nearly as possible the same time the company reads it. The gas company's bill states the meter readings on the dates between which the bill applies, so that checking meter readings will be easy. Should the meter readings not be given on the bill the consumer can estimate them and determine the amount of his bill if he knows the price of gas per thousand cubic feet. Should the consumer take on meter reading at the proper time and miss the next one, it is obvious that he can still check up the gas bills by taking a subsequent reading when the gas company's reader again calls, calculating the cost of gas used between his readings and comparing this cost with the sum of the amounts of the bills for gas between these same dates.

If a japanner's gas bill for a certain period greatly exceeds that of the previous period, it may be due to one or more of the following causes:

1. An increased consumption of gas—an investigation of the use made of gas during the period covered by the bill will often reveal the fact that an unusual amount of gas has been consumed.
2. A reading or clerical error on the part of the gas company. If the consumer reads his own meter and checks the bill, the question as to whether this is the cause can be quickly ascertained.
3. A fast meter. If causes (1) (2) or (4) apparently do not exist, the consumer may naturally consider that his meter is fast.
4. Leaky gas pipes will show an increased consumption, especially if the leak is on the gas-using side of the meter.

OPERATING COSTS of gas are most important to the japanner. The cost of gas consumed per hour, with only a little trouble can be determined whether it be that of operating a gas light or an oven by placing in operation the appliance in question and having all other gas-using appliances shut off. Then, by observing the *testing circle* of the meter, determine the time in seconds required for one, two or more cubic feet of gas to pass. The number of cubic feet of gas per hour is then determined in the following manner: (1) Divide the number of cubic feet burned during the test by the number of seconds, thus determining the number of cubic feet of gas used per second, and (2) multiply the result by 3,600 (the number of seconds in an hour).

EXAMPLE: It is observed that with an oven in operation the meter indicates the passage of two cubic feet of gas in one minute and forty seconds. Applying the above rules,

$$\frac{\text{Cubic feet}}{\text{Seconds}} \times \text{seconds in an hour} = \text{cubic feet of gas used.}$$

$$\frac{2}{100} \times 3600 = 72$$

Cubic feet of gas used × rate = cost of gas per hour
72 × $1.00 = $.072 per hour

DIAL THERMOMETERS are those which are usually placed in the oven door. They have a dial with a hand indicating the temperature.

Dial thermometers used to be in bad repute. They were not accurate, sensitive and reliable, hence were not seriously considered for industrial or power plant purposes, because the dial thermometers depended upon either the relative expansion and construction of two metals, or upon the expansion and contraction of a liquid, usually spirits of ether. The former method is unsatisfactory, because indications are slow and inaccurate. The fault in the latter lies in the fact that both ether and spirits expand and contract very unevenly, making it impossible to graduate such a thermometer correctly.

In the construction of successful dial thermometers mercury is used as the medium for indicating the temperature. Mercury is said to be the best substance for this purpose. The use of mercury in thermometers other than glass tube thermometers, however, is a new departure and was made possible by the use of a mechanism, consisting essentially of a steel bulb, steel capillary tube and steel coil spring, all filled with mercury. The expansion and contraction of the mercury due to the temperature changes is transmitted to the spring and the temperature reading is indicated by a pointer on the dial.

These thermometers may not indicate the true temperatures of the oven, because the door in which they are mounted never gets as hot as the rest of the oven and often takes much longer than the rest of the oven in heating up. Since temperatures sometimes need not be known within 10 degrees or 20 degrees, such thermometers are useful and they are more convenient than those which are hung inside the oven. A thermometer made to read up to 550 degrees F. may be hung inside the oven, but the door must be opened, or a window provided, in order to read it.

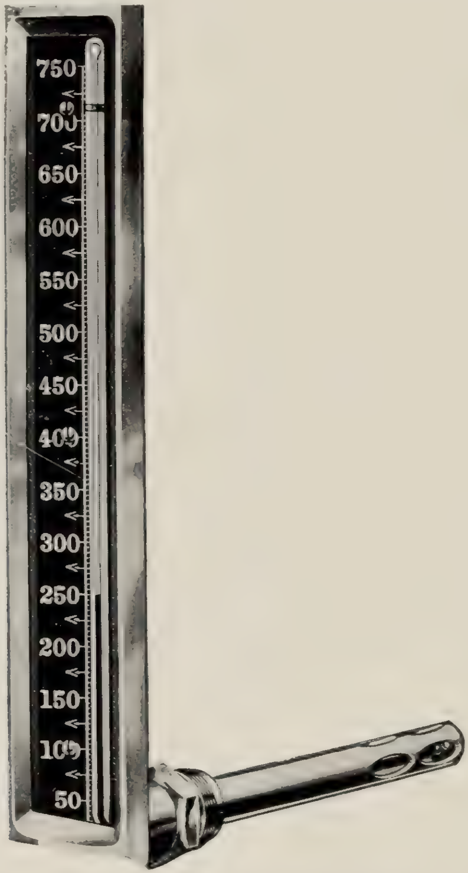

Figure 113—An Angle Thermometer

Angle Thermometers are valuable oven accessories. A high-grade instrument of the angle type (Figure 113) will indefinitely preserve its accuracy; will act as a check on any other instruments used; and is easily read, even by an inexperienced operator. The illustration shows the swivel nut of the union used for attaching and also the guard protecting the bulb.

Recording Thermometers (Figure 114) make permanent 24-hour charts of the oven temperatures. After a certain shape of curve (Figure 115) has been found best the operator can easily duplicate results.

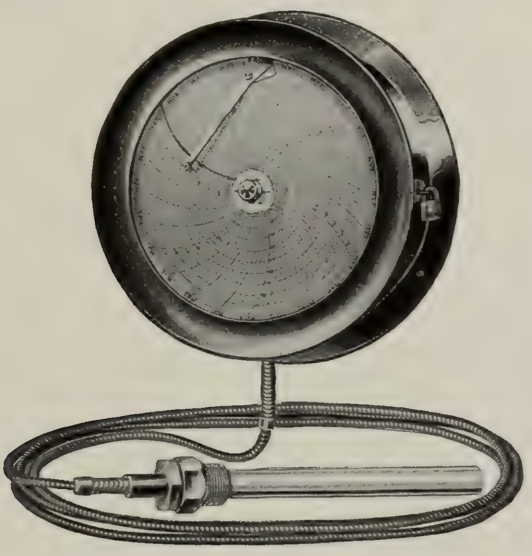

Figure 114—An Indicating and Recording Thermometer

The curve shown here tells the oven temperature as well as the production story for 24 hours. Work of loading started at 8 a. m. The oven was lighted at 10 a. m. and the bake finished at 12:15 p.m. During the unloading period which lasted until 1:20 p. m. the temperature of the oven dropped from 390 degrees F. to 160 degrees F. It is very interesting to observe at this point the serious loss in production occasioned by the drop to 160 degrees F. in oven temperature, for it was not until 2:05 p. m. that another heat was finished. This curve shows that there were five oven loads produced on that day. The cover of the recorder is equipped with a lock, thus making the thermometer accessible only to those in general charge of production who can determine at any time with what care the oven is being operated. Greater operating care, better bakes, and lower costs are the results.

An Automatic Temperature Controller is a device which automatically regulates the supply of heat for maintaining a desired temperature. It is quickly adjustable. It saves the time required for watching and regulating temperature and does away with overheated and spoiled bakes, which otherwise occasionally occur. Heat economy follows, as only such gas, electricity or steam is used as is necessary for the desired temperature.

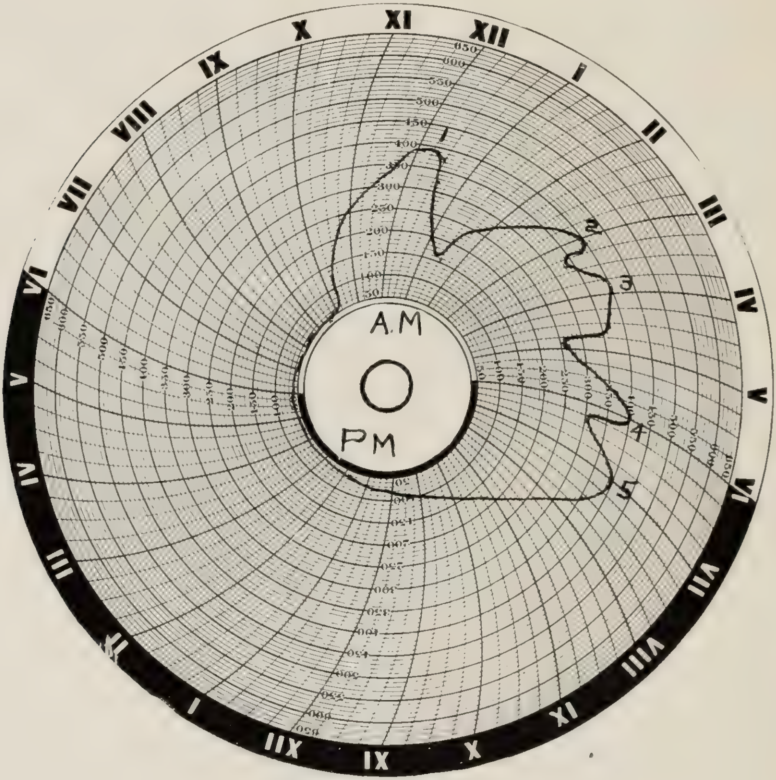

Figure 115—A Recording Thermometer Chart

The controller is furnished with a plainly marked temperature scale. This answers two purposes: first, it permits easy setting of the control point, without the necessity of referring to any other instrument as a check; second, the indicating arm which is continually pointing to the proper temperature follows exactly the cycle of temperature and is of value as a source of information as to whether the apparatus is coming up to heat. When the indicating arm reaches the point of control, it continues to indicate at the proper temperature graduation and the user automatically knows that the control is being properly carried on.

Figure 116 illustrates the reason why the indicating arm, which is shown in between the two contact arms, moving in either direction, will strike the contact points. These, by small springs, are held in contact with the indicating arm. Regardless of how far up or down the scale the indicating arm moves, the high or low contact in circuit continues to press against the corresponding point on the indicating arm. The above type is suitable for temperatures from approximately 90 degrees to 500 degrees F. It is vapor-filled and is operated by the expansion of this vapor.

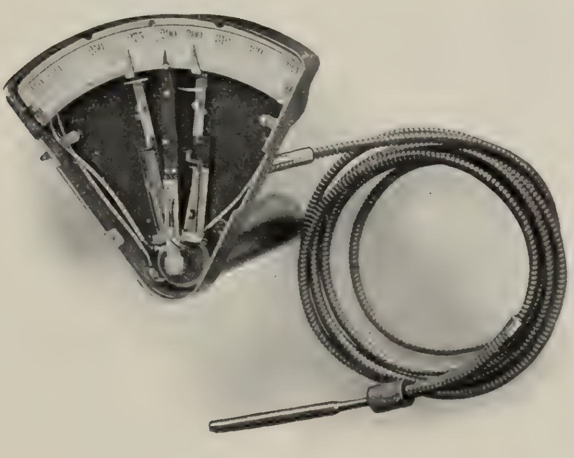

Figure 116—A Temperature Controller

Figure 117 shows the simplicity of such a controller with gas and air valves for operating gas-heated ovens. By substituting other types of valves, or electrical switches this same controller is made suitable for service in connection with ovens heated by other fuels than gas.

Time Indicators are convenient reminders which the operator may set by hand to show when the bake started and when it should end.

There are many items which can be standardized only in part. There are dipping and settling tanks, drain boards, conveyor shields, racks and other supports for work, structural work for conveyors, oven stacks, and so forth.

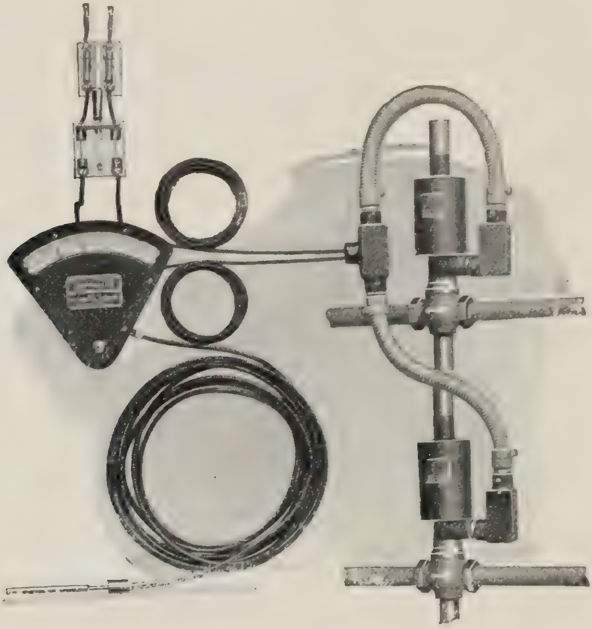

Figure 117—Temperature Controller (Method of Installing)

Fans or Blowers are occasionally needed for ventilating the oven—for supplying, for example, air or gas pressure for large gas burners.

Automatic Cut-offs are safety devices used to control the gas supply in case the pressure in the mains should fail.

Proportional Mixers are used to control the mixture of gas and air under varying pressure and consumption conditions.

Premixing Machines (motor driven) are used to obtain accurate and correct mixtures of gas and air in order to secure the best possible combustion efficiency.

Ventilators are very useful with a natural draft. It is important that the exposed end of the pipe be covered with a rain cap (Figure 118). The wind blowing across the top creates a slight vacuum which assists in drawing the fumes out to the open air.

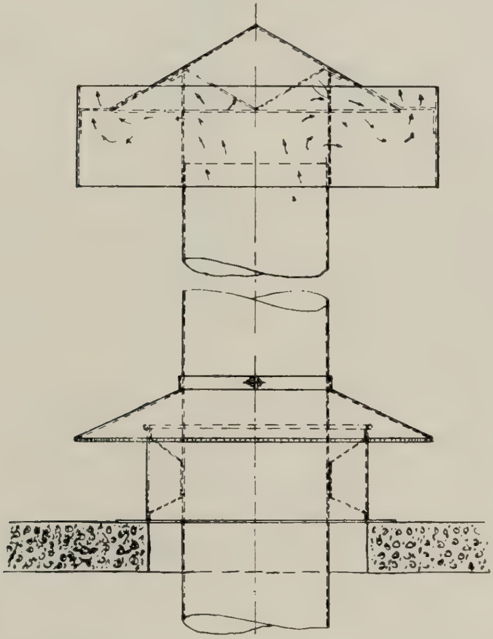

Figure 118—Ventilator with Rain Cap and Coaming

The Viscosity Cup[1] (Figure 119) is the simplest form of instrument for measuring the viscosity of a solution.

It is a cup of a certain capacity and having a hole in the conical bottom of such a size that when the finger is released from this hole the contents of the cup will flow out in a certain number of seconds. It is calibrated on the basis of turpentine flowing out in *30 seconds.*

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[1] Invented by Franklin Bradley.

Should any dirt get in the hole through which the material to be tested is to flow, there would naturally be an irregularity in the result and all comparative readings would be upset and of no value.

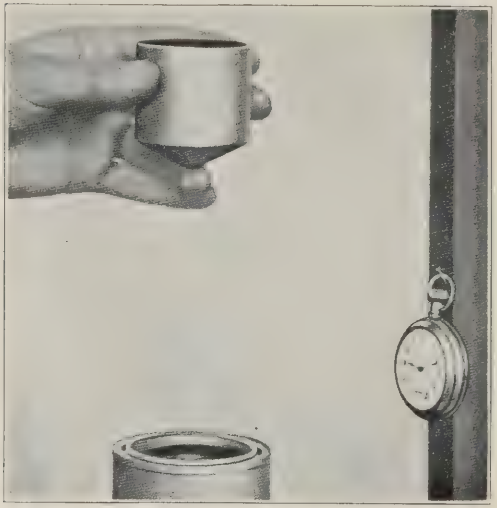


Figure 119

THE VISCOSITY CUP (CLOSED)

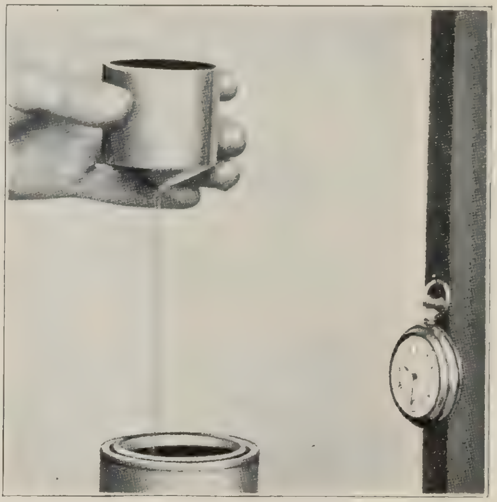


Figure 120

THE VISCOSITY CUP (OPEN)

Therefore, it is first necessary to check the flow of the cup with turpentine at 60 degrees F. The room temperature is another important factor, and where the readings are taken at other than 60 degrees it is necessary to note also the temperature so that the correct viscosity may be calculated.

With this cup the viscosity of the various materials that are tested are said to correspond to the number of seconds it takes for the material to flow out, and since viscosity is a measure of the flow it is evident that a thick, slow-flowing material will take longer than one that is thin and fast-flowing.

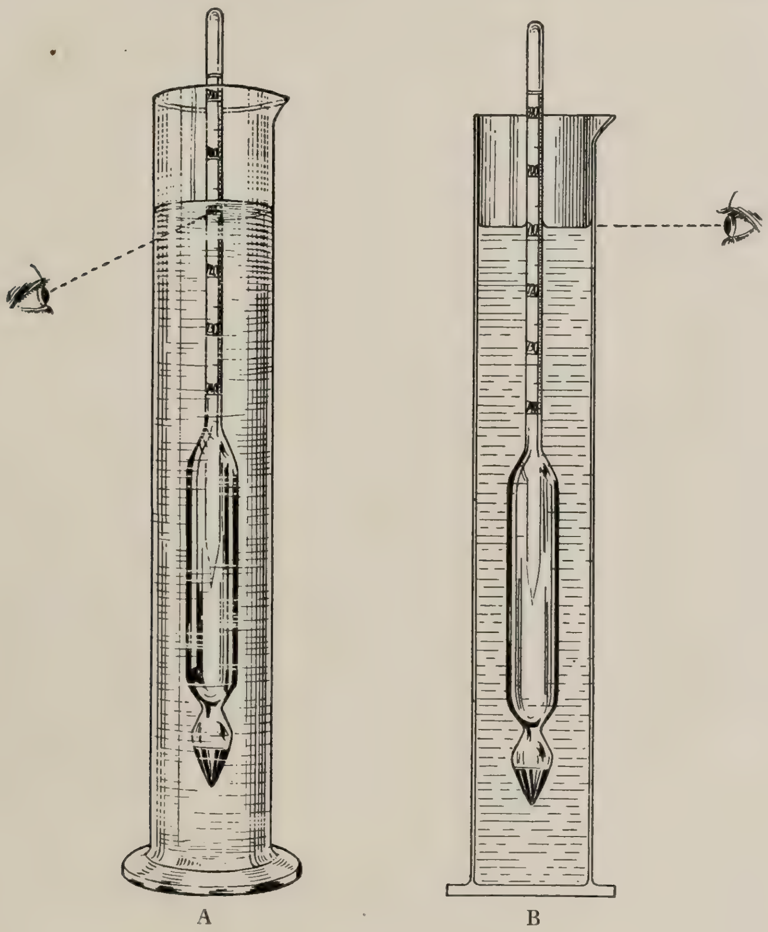


Figure-121—Reading an Hydrometer

To operate the viscosity cup properly, it is necessary that the cup be held perfectly level. If a stop watch is not available an ordinary one having a second hand will do. Release the finger from the hole in the bottom of the cup (Figure 120) and note the time when the flow starts as well as when it stops. The number of seconds elapsing between these two operations will be the abstract factor that will represent the viscosity as compared with either turpentine or other materials that are tested in the same cup.

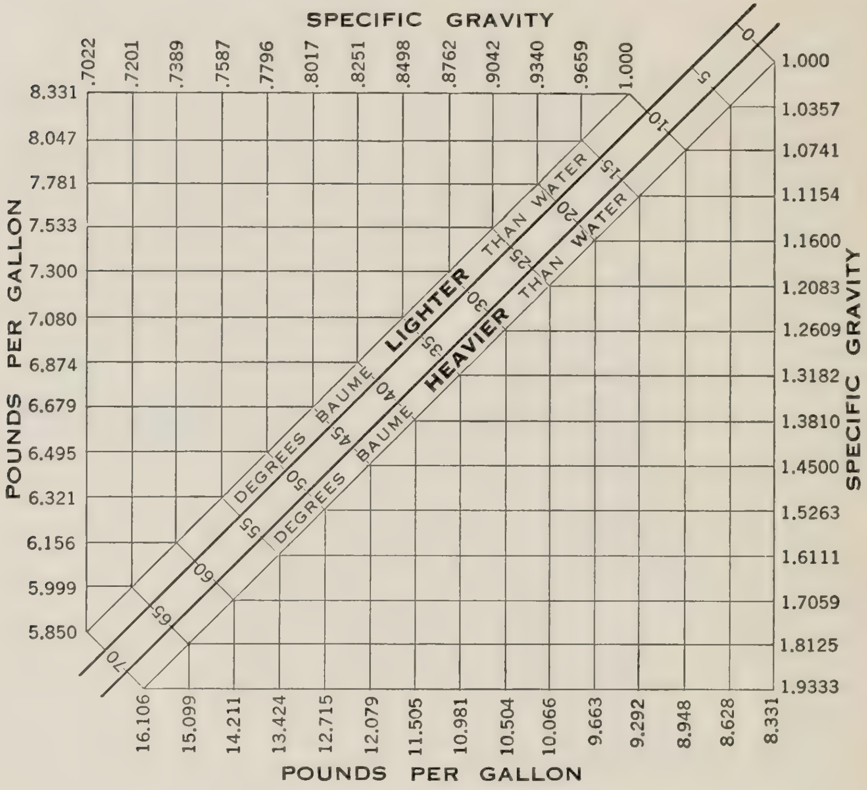


Figure 122—Specific Gravity Conversion Chart

The Hydrometer (Greek for water measure) is used to determine the specific gravity. It is a small glass instrument, (Figure 121) which is floated in the liquid to be examined. The point on the stem of the hydrometer to which it sinks in the liquid is the specific gravity. The scale is made up on the basis of a floating body sinking into the liquid to a point where the weight of a liquid displaced equals the immersed portions of the body.

To use an hydrometer, a sample of the liquid to be tested should be placed in a glass cylinder slightly larger than the hydrometer itself. The liquid should be well stirred, and whenever the reading is to be accurate it should be taken at either 60 degrees F. or the temperature at which it is taken should be recorded, after which the results may be refigured and basically reduced to the standard temperature.

The surface of the liquid in the glass tube should be raised, not below the line as indicated in Figure 121-A, but to a level of the eye as indicated in Figure 121-B. The line where the surface of the liquid appears to cut the stem of the hydrometer is the specific gravity. Should the liquid be black it will be necessary to estimate the reading.

TABLE 17

DENSITIES OF VARIOUS MATERIALS

SUBSTANCE	SPECIFIC GRAVITY
Air, dry	.0012
Air, 50% humid	.001195
Gasoline	.70
Kerosene	.78
Turpentine	.86
Linseed Oil	.92
Ice	.92

NOTE—The above values are taken at a temperature of 68 degrees F.

The density of an oil or other similar material is an index of its physical properties and of its quality as will be seen by referring to Table 17.

Most materials used in the finishing room are measured by either the Baumé scale, an arbitrary set of figures originated by a French chemist named Antoine Baumé, or the specific gravity, the relation of which is seen by referring to the specific gravity conversion chart (Figure 122).

It is always necessary to state the name of the scale used, such as Baumé, as there are several and the figures only do not mean anything except in the case of specific gravity.

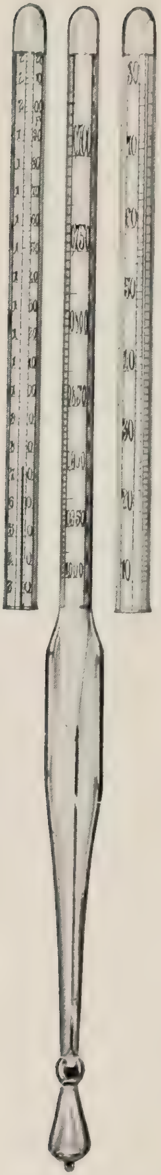
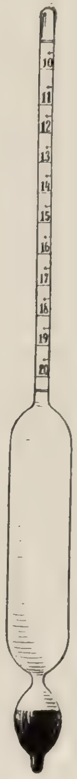


Figure 123
An Hydrometer for Liquids
LIGHTER than Water

Figure 124
An Hydrometer for Liquids
HEAVIER than Water



The measure of the density of a material is its specific gravity which is the ratio of the weight of any volume of a substance to that of an equal volume of water. The values representing it are stated in grams per cubic centimeter and are numerically the same as the specific gravity in terms of water at 4 degrees C. as a basis.

There are two kinds of hydrometers—one for measuring liquids lighter than water (Figure 123) and the other for measuring liquids that are heavier than water (Figure 124).

There is a difference in the starting point of the two Baumé scales. That for liquids lighter than water starts at 10 while the other starts at zero.

There are also available hydrometers in which two types are combined into one and still others which have thermometers sealed within them.

Paints, varnishes, oils, solvents, and alcohol solutions are in general *lighter* than water and require an hydrometer with the scale increasing upward from the bulb.

Some paint and lacquer materials are *heavier* than water and require the other type—a scale decreasing upward from the bulb.

XVIII

HOUSEKEEPING AND HAZARDS

Fire
A Fire in a Japanning Shop
Fire Prevention Regulations
Carbon Tetrachloride
Causes of Japanning Fires
Other Fire Extinguisher Formulae
Canvas Curtains
Hand Fire Extinguishers
Sand
Chemical Fire Extinguishers
Safety Cans
Sprinkler Systems
Safety Dipping Tanks
Paint Materials
Shock Hazards
Lead Poisoning
Fire Hazards from Overloaded Wires
Improper Fuses

Fire is the combination of oxygen with any substance heated to a temperature above the burning point. There are two ways to extinguish a fire: to cool the burning substance below its burning point, or to smother the fire by excluding the oxygen. Any fire that is not extinguished by one or the other of these methods, or by a combination of both, must burn itself out. Water is considered the most potent extinguishing agent, since it can be had in unlimited quantities. It is, nevertheless, a slow and, in most cases, a costly method, since it has to be used in such large quantities to put out the fire that it often does more damage than the fire itself.

Water cools burning substances below their burning point, and has a cooling effect when a stream is flowed on the burning surface. However, in the case of inflammable liquids the use of water multiplies the danger of the blazing liquid. Chemical solutions are much better than water because, in addition to the water which enters into their composition, they carry carbon dioxide, a fire-smothering gas, to the blaze.

A Fire in a Japanning Shop is a serious thing, as will be seen from Figure 125.

Strange as it may seem, this fire was not caused by anything that had to do with japanning, having been set on fire by an outsider. Thus not all fires in japanning plants start from within.

When electric japanning ovens were first introduced they were

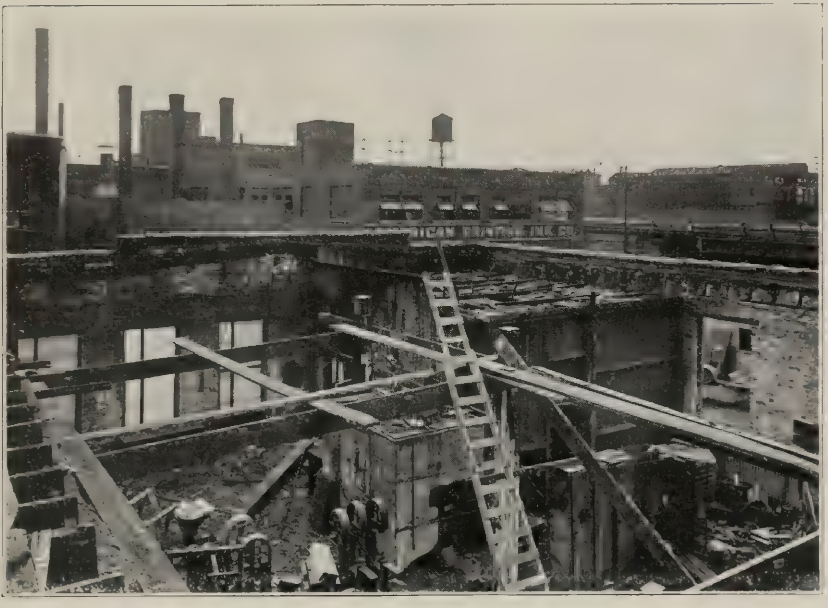
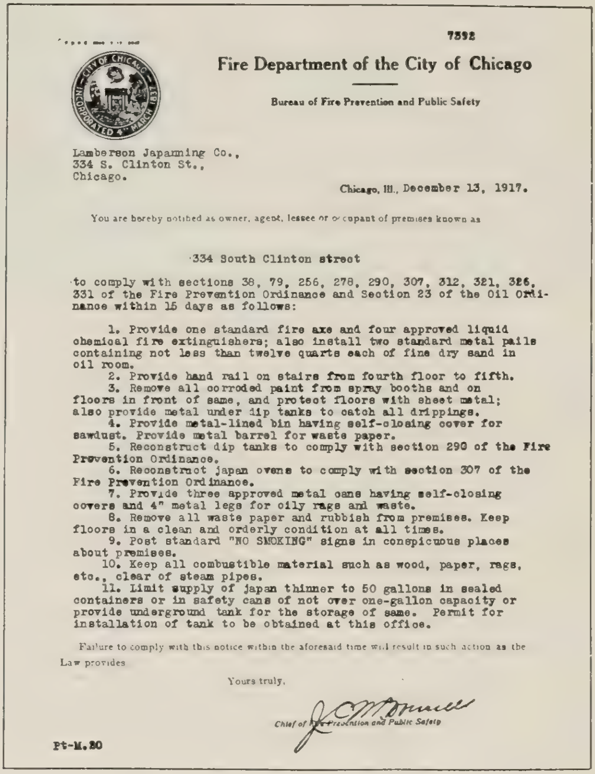


Figure 125—A Japan-shop Fire

expected to limit japanning fire hazards, and later fires in electric ovens seemed to prove the fallacy of these early expectations. Latest information indicates that these fires were all due to easily preventable causes and should not be blamed on electric heaters. In modern installations the causes are eliminated and the japanning equipment may be called fire-proof so far as the design of the oven is concerned.

Fire Prevention Regulations are strict. In fact, the insurance companies consider the risk very great and consequently keep their insurance rates high. Of course, they can hardly be blamed for this because of the mysterious atmosphere surrounding the japanning industry in the past. Even the fire department is not as well acquainted with the industry as it should be, since there has been passed certain fire prevention ordinances which are based on *general* fire prevention, rather than on complete and thorough knowledge of japanning. However, the notice reproduced herewith (Figure 126) which the Lamberson Japanning Company received from the Chief of Fire Prevention of the City of Chicago, shows the efficiency and thoroughness of this department.

The changes that would have to be made, as demanded in this letter, were so extensive in a rented space that the company decided to move into a new plant. We were anxious to comply with the demands made, because we knew they were for our own good. With this end in view we co-operated with the Fire Prevention Bureau to make our new shop as near fire-proof as possible. However, our experience since that time has proven that there are a number of other rules which should be made and rigidly enforced also.



7592

Fire Department of the City of Chicago

Bureau of Fire Prevention and Public Safety

Lamberson Japanning Co.,
334 S. Clinton St.,
Chicago.

Chicago, Ill., December 13, 1917.

You are hereby notified as owner, agent, lessee or occupant of premises known as

334 South Clinton street

to comply with sections 38, 79, 256, 278, 290, 307, 312, 321, 326, 331 of the Fire Prevention Ordinance and Section 23 of the Oil Ordinance within 15 days as follows:

1. Provide one standard fire axe and four approved liquid chemical fire extinguishers; also install two standard metal pails containing not less than twelve quarts each of fine dry sand in oil room.
2. Provide hand rail on stairs from fourth floor to fifth.
3. Remove all corroded paint from spray booths and on floors in front of same, and protect floors with sheet metal; also provide metal under dip tanks to catch all drippings.
4. Provide metal-lined bin having self-closing cover for sawdust. Provide metal barrel for waste paper.
5. Reconstruct dip tanks to comply with section 290 of the Fire Prevention Ordinance.
6. Reconstruct japan ovens to comply with section 307 of the Fire Prevention Ordinance.
7. Provide three approved metal cans having self-closing covers and 4" metal legs for oily rags and waste.
8. Remove all waste paper and rubbish from premises. Keep floors in a clean and orderly condition at all times.
9. Post standard "NO SMOKING" signs in conspicuous places about premises.
10. Keep all combustible material such as wood, paper, rags, etc., clear of steam pipes.
11. Limit supply of japan thinner to 50 gallons in sealed containers or in safety cans of not over one-gallon capacity or provide underground tank for the storage of same. Permit for installation of tank to be obtained at this office.

Failure to comply with this notice within the aforesaid time will result in such action as the Law provides

Yours truly,

Chief of Fire Prevention and Public Safety

Pt-M.20

Figure 126—Fire Prevention Notice

It is not right that the man who installs modern equipment should be made to suffer for the sins of the man who builds his own. The insurance inspector looks upon a japanning oven as a japanning oven, with no credits for refinement in design. It is up to you readers to make him change his mind and lower your rates, which he will do as soon as the fire losses in japanning departments and plants stop.

The following exceptions are taken to the present ordinances of the City of Chicago:

1. The present fire ordinance permits the use of fused asbestos board, consisting of alternate layers of flat and corrugated sheets of asbestos. This should be changed to require the use of insulation made of diatomaceous earth as a minimum standard.

2. The present ordinance specifies that vents for ovens over 200 cubic feet capacity shall have 20 square inches of vent pipe area for each 100 feet capacity. For an oven 7 x 8 x 6 feet this would mean 336 cubic feet, or at least 60 square inches area of vent capacity—in other words, a vent taking care of this oven 6 feet x 10 feet (based on an oven capacity of 300 cubic feet instead of 336 cubic feet). This is not enforced because there are many ways to overlook it. These area provisions are little enough, but when a man in a several story building is allowed to run his vent pipe into a chimney that is used by other tenants and for other purposes, that japanning oven does not have the proper ventilation.

3. The department at the present time interprets the rules covering the installation of open flame ovens to cover only new installations, permitting the existing open-flame type ovens to remain. Until the open-flame oven is absolutely prohibited there is going to be extensive loss by fires starting in japanning ovens, particularly those used in individual plants.

4. The ordinance requires a hinged relief door in the top of each oven, the area of which shall be four square feet for each 100 cubic feet of oven capacity. We are unable to see what difference it makes whether the door is hinged or not—in fact, an unhinged door would be a trifle safer. This provision is exceedingly important in case of explosions caused by a leak in the gas pipe which might fill up the oven. The pressure on the relief door will positively save loss of life, or prevent injury from explosion, since the force of the explosion would be spent in opening the relief doors instead of blowing up the entire oven.
   This ordinance is not enforced because the department does not realize the danger. There are hundreds of open-flame japanning ovens in use, even in Chicago, with either no relief door or, if the ovens have relief doors, they are under size.

5. The ordinance now requires vapor-tight incombustible walls for japanning departments. Hollow tile is a typical material for this use. The use of wooden or wall board partitions inside of the japanning department or plant should positively be prohibited.

6. To prevent spontaneous combustion the ordinance provides for keeping oily rags in standard self-closing cans. I would further insist that these cans be kept filled with water which would positively prevent any combustion from starting.

Spontaneous combustion is now supposed to be due to drying oils being spread out in a thin layer and subjected to oxidation in a small space away from radiation (this oxidation, under ordinary conditions, is a very slow process—when it is not confined.) Such a condition exists when the oil is spread on rags or tightly rolled waste. This confinement causes the temperature to rise to the ignition point. The iodine number of drying oils may be taken as a gauge of their susceptibility to spontaneous combustion. Linseed oil has a high iodine number and is very susceptible. Boiled linseed oil is more susceptible than raw.

7. Powdered charcoal, lampblack, unslacked lime, gasoline, and non-safety matches should all be kept in separate metal boxes in the stockroom. All are liable to start spontaneous fires, except the matches, which must be kept away from rats.

   The principal danger from gasoline devices is in having the gasoline about. At ordinary temperature gasoline continually gives off inflammable vapor, and a light some distance from the material will ignite it through the medium of this vapor. *The vapor from one pint of gasoline will make 200 cubic feet of air explosive.* It depends upon the proportion of air and vapor whether it becomes a burning gas or a destructive explosive. Beware of any leaks and never forget how dangerous a material is being used.

8. In the case of old direct-gas ovens the regulations read as follows: "Direct fire heat is not approved. If used the hazard may be reduced by cutting off the baking compartment from the fire chamber and smoke flue by a tight incombustible partition. Provision must be made to keep the flames at such a distance from the partition as to preclude the possibility of heating it sufficiently to ignite the fumes in the baking compartment—baffle plates or cylinders used for this purpose should be at least ⅜ inch thick. The burner end of the oven should be in a separate room cut off from the oven room by vapor-tight partitions and be entered only from the outside of the building.

   The fact is that it would not be possible, under these conditions to get enough heat radiation (which would then be confined to that equal to the area of floor space covered by the oven) to perform the japanning operation. The danger in this provision lies in the fact that a fire inspector, hueing closely to the rules, would overlook what might be an extremely dangerous condition.

CARBON TETRACHLORIDE is a liquid which has a boiling point of 75.1 to 76.8 degrees C.; specific gravity 1.601 at 15.5 degrees F.; freezing point, —22 to —23 degrees C.; is free from water, acids and water soluble chlorides; contains approximately 0.1% (by weight) carbon disulphide.

It is a well-known fact that carbon tetrachloride makes one of the very best fire extinguishers known, on account of the fact that it vaporizes at very low temperature, and the fumes thus produced extinguish fire immediately. This product will not freeze, will not damage material of any kind, and can be purchased for approximately $1.00 per gallon. Glass pint bottles filled with this product should be located conveniently. When thrown at a fire they will break and distribute the contents in a very effective manner. This type of fire extinguished is *not approved* for certain very good reasons, but is nevertheless a very good and effective extinguisher. Its use has prevented many serious japan-shop fires. Carbon tetrachloride is one of the few agents that is valuable in extinguishing oil fires and should therefore be available for use of all japanners.

CAUSES OF JAPANNING FIRES (Table 18) have been tabulated by the National Fire Protection Association:

TABLE 18

CAUSES OF JAPANNING FIRES

CAUSE	NO. OF FIRES	PER CENT OF WHOLE
Overheated oven	22	16.8
Explosions at oven	20	15.3
Smoking, matches or open flame in presence of japan	17	13.0
Heat from oven igniting combustible material near by	12	9.2
Defective, dirty or overheated flues	7	5.3
Accidental sparks igniting japan or its vapors	6	4.6
Fumes from oven ignited by open flame near by	5	3.8
Ignition of vapors from miscellaneous causes	5	3.8
Spark or flame from oven burners	4	3.1
Drippings igniting in oven	4	3.1
Accumulations of vapor due to poor ventilation of oven	4	3.1
Coating on stock ignited in oven	4	3.1
Stock placed in oven before properly dried	3	2.2
Carelessness in cleaning	3	2.2
Miscellaneous causes	15	11.4
	131	100.0

This association also gives the details of the causes of these japan fires, a few of which are quoted herewith:

1. Open gas-jets were located over two uncovered dip tanks. In lighting one of the gas-jets an employee dropped a lighted match into a tank. The loss amounted to about $4,300.00.

2. Vapor from a japan tank floated through the air to a coke furnace in the next room, which was used to heat a japan oven. The rooms were not cut off in a standard manner, and fire flashed back to the tank, doing damage to the extent of $1,357.00.
3. A brick japan oven was built against a wooden wall. It is believed that the wood in contact with the oven became charred and that a spark escaping between the bricks of a chimney with which the wall was also in contact readily set the wood afire.
4. Fire occurred in a seventeen-inch vent pipe which communicated with smaller pipes from the hoods over four japan ovens. Undoubtedly the pipe contained an accumulation of semi-solids from condensation of japan vapors, and these in some way became ignited. After the fire, cleaning holes with slide covers were made in the pipes with the object of preventing a recurrence of the hazardous condition. The loss was about $425.00.
5. Disregarding his instructions, a night oven-tender was using a pail of gasoline to clean japan from the floor near a lighted oven. Explosive vapors were drawn into the oven by the draft through the oven ventilators and ignited, setting fire to the pail of gasoline and japan in drip pans and dip tanks. Twenty-six sprinklers operated promptly and controlled the fire.
6. Three gas-fired ovens were installed with direct communication between them near the floor beneath the burners. One of the ovens was not in operation at the time of the fire, and it is supposed that one of the gas-cocks in that oven was not closed tightly and allowed gas to escape into the adjoining oven, where it became ignited.
7. Japanning processes were not cut off and the building as a whole was unsuited to its occupancy, being brick joisted construction. All floors in the japanning section were thickly encrusted with paint and oils, and fire spread very rapidly. The loss was $87,545.00.
8. The oven in which explosion occurred was constructed of brick and heated by fuel oil, which was burned in a flue under the floor provided with iron-plate covering. It was the practice to keep a damper open in the ventilating flue of the oven when the work was first put in, the damper being closed gradually as the baking progressed, although the intention was never to have it completely closed. The chances are that at the time of the explosion the damper had been fully closed, by mistake, allowing an accumulation of gases which formed an explosive mixture with air. The property damage, which was all due to the explosion, amounted to $2,000.00.

OTHER FIRE EXTINGUISHER FORMULAE are given as follows:

1. Liquid Fire Extinguisher
   4 ounces calcium chloride
   1 ounce sodium chloride
   15 ounces water
   The resulting solution is thrown into the fire by a hand pump. The burning portions become incrusted and cease to be combustible.

2. Liquid Fire Extinguisher
   1 ounce sodium nitrate
   1 ounce sodium chloride
   1 ounce ammonium chloride
   1 ounce magnesium chloride
   16 ounces water
   This solution is put in a hand-pump for use.

3. Dry Fire Extinguisher
   15 ounces potassium nitrate powder
   9 ounces sulphur powder
   1 ounce charcoal wood powder
   ¼ ounce colcothar or rouge
   (Caution:—This is almost the formula for gun powder.)
   Dry thoroughly, then mix and fill into round pasteboard boxes holding five pounds. A fuse which extends some four inches inward and about six inches outwards should be introduced through an orifice in the side. The later end fastened on the outside of the box should have a strip of red paper pasted upon it bearing the inscription "Light Here."

CANVAS CURTAINS may be fairly well fire-proofed by soaking them for 10 minutes in the following:

1 pound ammonium phosphate
1 gallon water

HAND FIRE EXTINGUISHERS usually have a capacity of one quart. Extinguishers utilize as agents special liquids with the important component of depressing the freezing point, and so forth.

SAND is one of the most valuable fire extinguishers available in putting out fires in japan shops. There should be several buckets of it kept in red-painted, round-bottomed pails hanging in each shop and especially near fire danger spots.

CHEMICAL FIRE EXTINGUISHERS are made in a number of styles as follows:

1. Anti-freeze
2. Hand pump
3. Stationary
4. Foam
5. Sprinkler
6. Carbon dioxide

From this it will be seen that there is one to fit almost any need.

Safety Cans about the shop can save many losses and in addition help get out a cleaner product. These receptacles, commonly designated *Safety Cans,* are designed for the storage and the handling of open stock of benzine, gasoline, and other flammable liquids. While not reducing the dangerous character of the liquids which they contain, they are considered as mitigating the extremely dangerous conditions attending the storage and handling of flammable liquids in common light sheet-metal and glass receptacles generally used for this purpose.

Sprinkler Systems may or may not be a part of the building equipment, but when the japanner is able to find a building with them in he is likely to find his insurance will be one-fifth of what it might otherwise be. As it is of vital importance that the design of a sprinkler system and the quality of the materials entering into its construction should be of the highest grade, careful consideration should be given to the experience and reliability of the companies making a specialty of this business. Open sprinklers are intended for use in connection with protection of windows, frame buildings, and so forth, from exposure fires. Some manufacturers furnish sprinklers with their equipment.

Safety Dipping Tanks are required by the Insurance Underwriters' Association, and by certain city departments. The great hazard of using old-style dipping tanks is well known. The safety dipping tank is constructed of steel, with a sliding automatic cover and an automatic emptying device. The cover is operated on an inclined track and held open by a hook which is weighted at the ends and held in place by a chain with a fusible link. The emptying valve is operated by a cam movement, which raises a mushroom seat inside of and at the lowest point at the bottom of the tank. The valve is held closed by a lever and weight which is attached to a chain with a fusible link. These fusible links operate at 150 degrees F.

In the event of fire, fusing of the links releases the weight on the hook, which permits the cover to close automatically and also releases the weight on the lever. This lever, by falling, raises the ground valve seat inside the tank and allows the liquid to flow to a place of safety outside the building.

Contrary to the common impression japan does not explode. In fact it catches fire very slowly (but surely). As the heat increases it burns more and more furiously until it finally turns into a high whirling mass of flame resembling a small cyclone.

Paint Materials as well as varnish and enamels present both a fire risk and a poison risk. Among the most dangerous materials are the heavy metal salts, such as those of lead and mercury used as pigments. Soluble lead salts in rather large quantity are necessary for acute poisoning when in contact with the skin for considerable lengths of time. Frequently these poisons occur as occupational disease. Among the most poisonous which is likely to occur is a salt of mercury, or vermillion.

The main constituent of wood alcohol, which is methyl alcohol, is very dangerous, on account of the paralyzing effect on the optic nerve, oftentimes causing blindness. Varnishes and shellacs containing it should never be used except in a well ventilated room—and in cold weather, if possible.

Linseed and other drying oils used in paints and varnishes are a dangerous fire risk, due to the rapidity with which they are spontaneously oxidized, causing elevation to ignition temperatures when distributed on rags, cotton, and so forth.

The most dangerous of all materials in this respect is silk, then comes cotton and then wool. Hence, boiled linseed oil containing driers, as well as raw oil, is dangerous. Rags soaked with oil should never be left where it is possible for them to ignite other materials. Metallic pigments similar to those used in paints and metallic salts for fixing dyes on textiles present a certain hazard. Caustic alkalis are also dangerous. Especial care should be taken when opening cans to prevent fine dust from lodging in the eyes or nose.

Shock Hazards resulting, for instance, from the deterioration of portable electric cords, varying with the moisture and the amount of handling to which they are subjected, should be carefully watched by ever japanner, and any broken covering should be repaired at once. If the covering is broken there is danger of the cord strands being broken and working through the insulating covering and also the outside covering. This would possibly cause these strands to be exposed to the contact of persons causing a shock hazard on the user.

It is well to have rolls of electrician's rubber and friction tape on hand for emergency. Cords should be as short as possible and should never be placed near radiators, cement floors, or such objects well connected with the ground, whereby a person touching the cord is apt to become a part of an electric circuit and receive a shock. The shock is apt to be very severe should a cord be injured, where conditions are especially bad for the deterioration of the cord, such as where surfaces are damp, or the air is filled with steam.

Lead Poisoning has been studied considerably by the United States Public Health Service, particularly in the pottery trades, and its report contains certain recommendations which will be found useful to japanners who do any considerable amount of color work. However, workmen are very unlikely to contract lead poisoning in a japanning shop. Should a case be discovered it is likely that the workman may have contracted it in a lead manufacturing factory.

It should be noted especially that the Workmen's Compensation Laws of some states hold the *last employer* responsible for diseases found in working men. This means that even if a case of lead poisoning were proven to be contracted in a lead manufacturing plant, the japanner would be held responsible.

To identify a case of lead poisoning in a workman, pull down the lower lip and examine the gums below the lower teeth. If a blue line is found across the mouth then the workman has lead poisoning. So far no preventive has been found. Therefore, it is recommended that the cause be removed by preaching sanitation and cleanliness to the workmen somewhat as follows:

Always eat a good breakfast.
Drink milk.
Never eat or drink in the plant or workroom, and do not drink from uncovered containers kept in the workroom.
Never wear street clothing in the workroom.
Never take work clothes home, and keep the work clothes and street clothes in separate lockers.
While at work do not chew tobacco or gum.
Do not spit on the floor.
Do not wear a beard.
Keep hair covered while in workroom.
When through work for day wash hands and face with hot water, clean finger nails and rinse out the mouth.
Avoid creating dust; only wet sweeping and wet dusting should be done.

To further prevent the causes the japanning plant wherever practical should be supplied with the following:

Bubbling fountains with good drinking water.
Adequate dressing rooms, with two-compartment lockers for each working man.
Decent and adequate toilet facilities.
Sufficient natural and artificial illumination and ventilation.

Fire Hazards from Overloaded Wires due to the passage of too great current through them may be guarded against by the use of fusible cut-outs. As all current of the installation pass through the incoming, or service wires, they will be the largest and the main fuses must be of such a size as to protect them against overheating. Within the building the circuits are so subdivided as to minimize the amount of energy which can be expended by the breakdown of insulation from mechanical or other causes.

These smaller circuits also have fuses of a size corresponding to the current-carrying capacity of the wires, and the devices are so constructed as to be reasonably protected against excessive current by the fuses employed.

In the interest of economy a standardization of these small circuits has taken place and the maximum size fuse permissible is 10 amperes with 110-volt circuits and 5 amperes with 220 volts. The size of wire may, of course, be larger for mechanical or other means, but should never be smaller than would be properly protected by these fuses.

Improper Fuses have caused many fires in japan shops. All fuses should be properly replaced when they *blow out,* which means the replacement by a fuse of the proper character and size. If the fuse is too large so that the devices which are being fed through it are not properly protected by it they may become overheated and may cause fires, or their insulation may break down and thus cause a shock or the burning of persons by arcs. For the larger circuits, including service wires, the rating of fuse should be properly proportioned to that of the wire.

Often the japanner is unfamiliar with the size of wires in use and should have the fusing of the different circuits properly inspected by those in authority. There is something wrong if the fuses blow out often and the cause should be found immediately.

In replacing fuses where any metal part used for carrying current can be touched, as is the case, for instance, with cartridge fuses, the installation should be provided a switch, the opening of which will disconnect such current-carrying parts from the circuit. In many of the older buildings wiring installations, the disconnection of the circuit to make the changing of fuses can be accomplished only at the main switch to the building, and this is a satisfactory arrangement except that it becomes necessary to cut the entire building out of service when it may only be necessary to repair one circuit.

To have each fusible cut-out arranged with a separate switch the operation of which will disconnect it is a much more convenient arrangement. The main switch should thus protect all the fuses in the building, including the main fuses.

XIX

LITHOGRAPHING OVENS

Lithographing and Japanning
Lithographed Productions
The Lithographic Press
Uniform Heat Is Paramount
The Field for Lithographing
Good Ventilation
Stationary Methods
The Continuous Conveyor Oven
Baking Temperatures
The Two General Classes of Ovens
The Hump Oven
A Horizontal Oven
The Cooling System
Sanitary Lacquer
Corn Lacquer
A Typical Layout

Lithographing and Japanning are closely related. Lithographing is usually applied to uniform-sized sheets which are later made into certain articles such as toys, cans, and so forth. The coating is very thin when compared to that of japanning which is applied after the article is completed. Ample ventilation is important in the ovens, as it is necessary to get rid of the volatile quickly in order to get fast production and cool the sheets for handling. This is usually done by passing a cool blast of air over the sheets after the coating has been baked on them.

Likewise, lithographing on paper and lithographing on metal are closely related. In the former all coating material deposited on the surface stays except, of course, that which is volatilized in the baking oven. In the latter much of the coating material is absorbed by the soft paper.

Lithographed Productions, if allowed to dry in the air at room temperature, would require from 10 to 24 hours for each color. Since the average job contains 5 or 6 colors or press runs and some jobs have as many as 12 to 20 runs, it is evident that air drying is entirely out of the question and oven drying is the thing. The drying time, where a properly designed and well-constructed oven is used, has been cut to less than 15 minutes.

The Lithographic Press (Figure 127) applies the material to the metal sheets after which they are automatically conveyed into the lithographic oven. As soon as they reach the opposite or *out* end of this oven they are dry and ready, either for fabrication or to be re-run to take another of the colors.

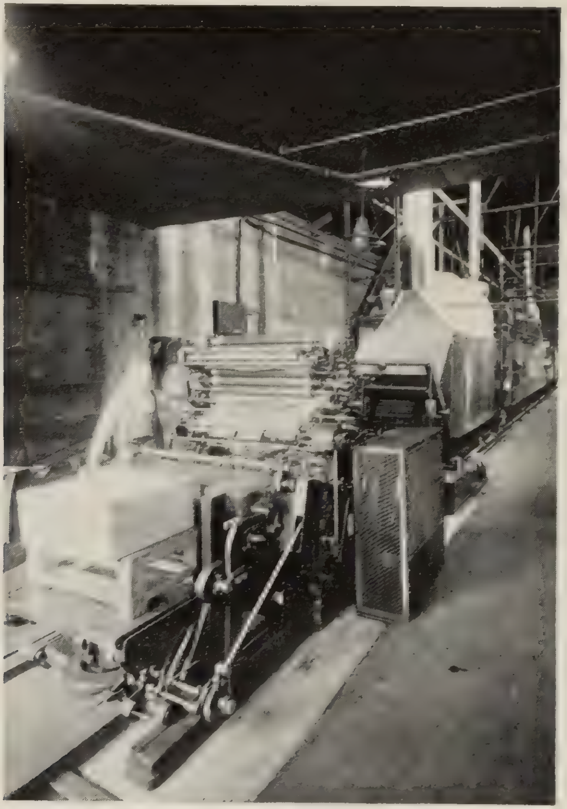


Figure 127—The Lithograph Press

Uniform Heat Is Paramount in a lithographing oven through which hundreds of sheets pass daily. Each color as it leaves the oven must be thoroughly dry to prevent offsetting on the bottom of the sheet next above when the sheets are stacked. On the other hand, if the ink be baked until it is brittle or until it loses its elasticity, the sheet would be ruined in subsequent pressing and fabrication. Each color when dried must be receptive to those which follow, to produce the proper composite effect in the finished design.

Where brittleness occurs—due to improper baking—an additional operation is made necessary in the stamping and pressing department later on. Brittle impressions have to be given a warm water bath just prior to machining.

The function of the baking operation is twofold: it volatilizes the thinner in the coating material and it oxidizes the drying oil. The volatile products are carried off immediately and are replaced by fresh air which enters the oven automatically.

The Field for Lithographing is rapidly extending. Some of the present uses are as follows:

- Ash trays
- Automobile license tags
- Badges
- Bale tags
- Bottle caps
- Bread boxes
- Buttons
- Calendar edging
- Candy boxes
- Cigar boxes
- Cigarette boxes
- Coffee caps
- Counter displays
- Crown caps
- Curtain rods
- Dry battery containers
- Food containers
- Games
- Grease cans
- Grinding compound containers
- Jar caps
- Kitchen articles
- Lard pails
- Match holders
- Metal furniture
- Metal signs
- Oil cans
- Paint containers
- Pen trays
- Radio accessories
- Shoe polish boxes
- Soap boxes
- Spark plug boxes
- Spice cans
- Talcum cans
- Tobacco cans
- Tool boxes
- Tooth paste tubes
- Toys
- Trays
- Trunk iron

Good Ventilation is very necessary to provide uniform heating. Indeed, these two factors go hand in hand to produce thorough volatilization and oxidation at maximum speed and with a minimum volume of air supply, which in turn means that the work done is handled with a minimum amount of fuel.

Should the sheets come out of the oven under-baked, partially dried coating material will adhere to adjacent sheets. On the other hand, should the sheets be over-baked, the lighter colors will darken and the artistic effect is likely to be lost. This is especially true when white is a part of the design.

When property baked, the lithographed sheets can be formed, bent or even creased, immediately after coming from the oven, without injury to the lithographed design. The proper baking equipment dries and hardens the coating materials uniformly and does not produce a hard surface film.

STATIONARY METHODS were formerly used before conveyors were introduced. The sheets, as they came through the press were racked by hand on a truck, so that they were flat. They were spaced one centimeter apart and baked in a kiln-type steam-heated oven. This type of equipment is still used for flat-bed press production, with one man feeding and two loading the racks.

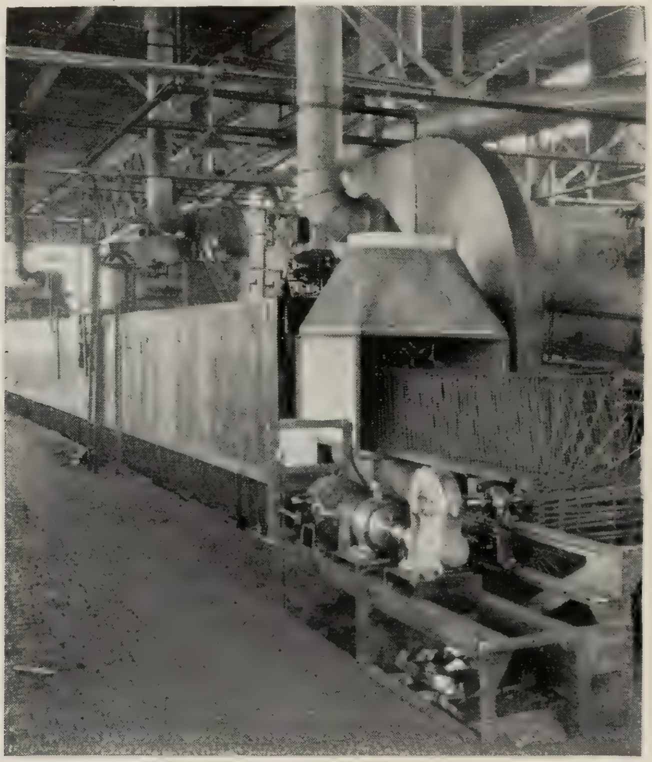


Figure 128—LITHOGRAPH OVEN (OUTLET END AND COOLER)

THE CONTINUOUS CONVEYOR OVEN is rapidly replacing these stationary methods. In it the printed sheets are delivered at the jaw clutch to the chain and finger conveyor, which passes through the oven and returns to the press or coating machine from below floor level. The fingers which hold the printed plates are rigidly mounted on light steel channels. In delivering the sheets to these fingers the jaw clutch slightly over-runs the conveyor and allows the sheet to drop into position between the finger loops. There is one sheet to each loop.

After leaving the press this self-loading conveyor, which incidentally is synchronized with the press action, proceeds into the oven, passing first through an air seal which holds the heated air within the oven proper. After traveling through the oven the conveyor carries its load through a multiple-pass cooler (Figure 128) to the unloading station, where the dry plates are removed and stacked. The helper who unloads the sheets grasps several at a time, pinching them together at the corner or by inserting his fingers between the sheets as they come up to him. In order to eliminate all unnecessary handling, the sheets as unloaded are stacked flat ready for the next press run. The conveyor delivers the cooled sheets about waist high (Figure 129) so that no motion is lost in stacking.

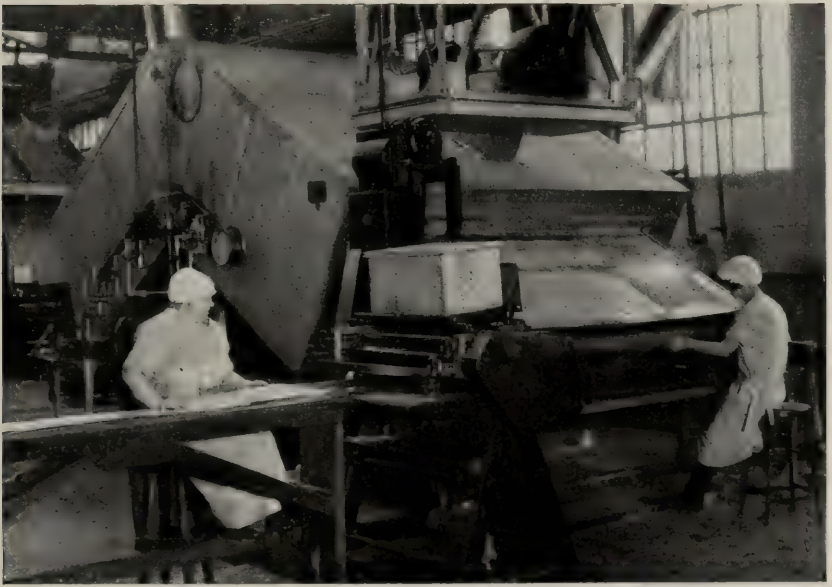


Figure 129—A CONTINUOUS CONVEYOR COATING OVEN

In the cheaper grades of work, where a slight movement of the finger loop across the face of the design is not objectionable, the conveyor can be arranged to unload automatically. In the movement of the plate from the conveyor to the stack, the face of the plate is thrown against a finger loop.

Baking Temperatures used in one of the largest metal decorating installations are from 125 degrees F. to 250 degrees F. for whites, 200 degrees F. to 300 degrees F. for the general run of colors and 200 degrees F. to 300 degrees F. for the various kinds of lacquers. The time of baking ranges from 30 minutes to one hour.

There is no particular limit to the size of sheet that may be handled in a lithographing oven (Figure 130). The fingers may be enlarged or even doubled to provide for a wider sheet.

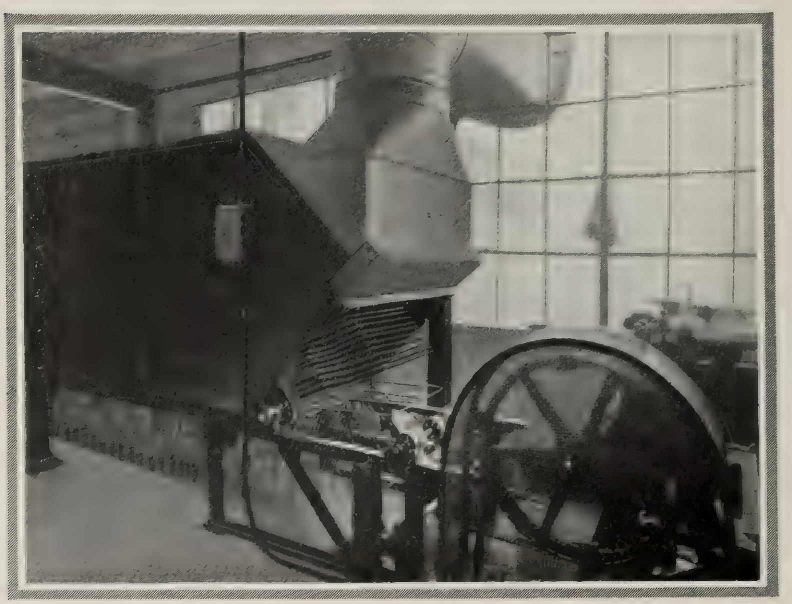
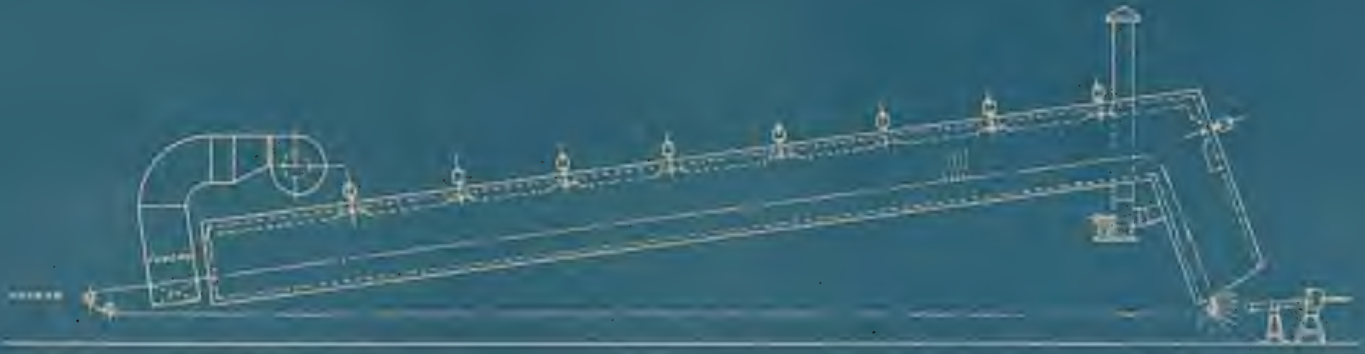


Figure 130—A Large Lithographing Oven

The Two General Classes of Ovens for producing lithographed parts are printing and coating.

An oven for use exclusively on coating is designed on the assumption that the finishing material is heavier than the deposit from a printing roll. In some cases it is heavy enough to sag or run, especially if the freshly run plates are held for any length of time in a plane approaching the vertical, before the oven heat has had an



Color Plate III.—A CONTINUOUS CONVEYOR COATING OVEN

opportunity to partially set the coating by driving off the volatile oils and thinner. The individual operations for which the oven is to be used must determine whether this sagging action is to be a limiting factor. If it is, the oven design will have to provide for it—if not, the same type of oven may be used for both printing and coating.

The heavier coating requires a greater amount of heat treatment. If the maximum temperature is limited and it usually is—the length of time for baking must be increased. A longer bake may be accomplished by reducing the conveyor speed or by lengthening the heat chamber of the oven. Usually the latter is necessary in order to maintain a predetermined production rate.

Therefore, the length of the coating oven is usually greater than that of the oven used exclusively to dry the printing-press run or lithographed sheets.

The foregoing statements must not be taken to mean that two types of ovens are necessary when the volume of work handled justifies but one.

The difference in the bake required is effected by regulating the fuel supply and conveyor speed.

THE HUMP OVEN (also called the L oven) is the solution to a problem which formerly gave lithographers a great deal of trouble, namely, the sagging of the material on heavily coated sheets. This trouble is eliminated when the sheets are kept in a horizontal position in the oven a sufficient length of time to give the coating material an initial set. The hump oven accomplishes this by inclining the course of the oven conveyor for the first stage of travel (Color Plate III). The conveyor finger loops lie horizontal and maintain this position until the apex of the oven is reached. The length of bake in this short leg of the oven sets the coating sufficiently to allow the sheets to be safely brought into practically a vertical position for the remainder of the bake.

The shape of the hump oven forms a natural seal to hold the heated air within the oven and to prevent its escape either at the entrance or exit ends. As a matter of fact this form admits of considerable variation to meet the specific needs of the individual plant. Instead of having the entrance and exit ends of the oven on the same floor they may be on different floors. Work may be fed to the oven on one floor and removed on the floor above. Also, the long leg of the oven, instead of being inclined, may be horizontal.

A Horizontal Oven is usually used where there is no coating and where printed work only is produced. Both types, of course, are equipped with finger carrier conveyors.

Regardless of the type of work, the continuous conveyor oven is usually equipped with an effective cooler located at the discharge end of the oven.

The Cooling System reduces the temperature of the dried sheets sufficiently to allow them to be handled without the use of gloves. This is of importance in volume production of high quality work, for in handling the sheets without gloves, the person who unloads is able to get a better purchase on the sheets and is not so likely to scratch or mar them, as he would were he handling hot sheets with heavy protective gloves.

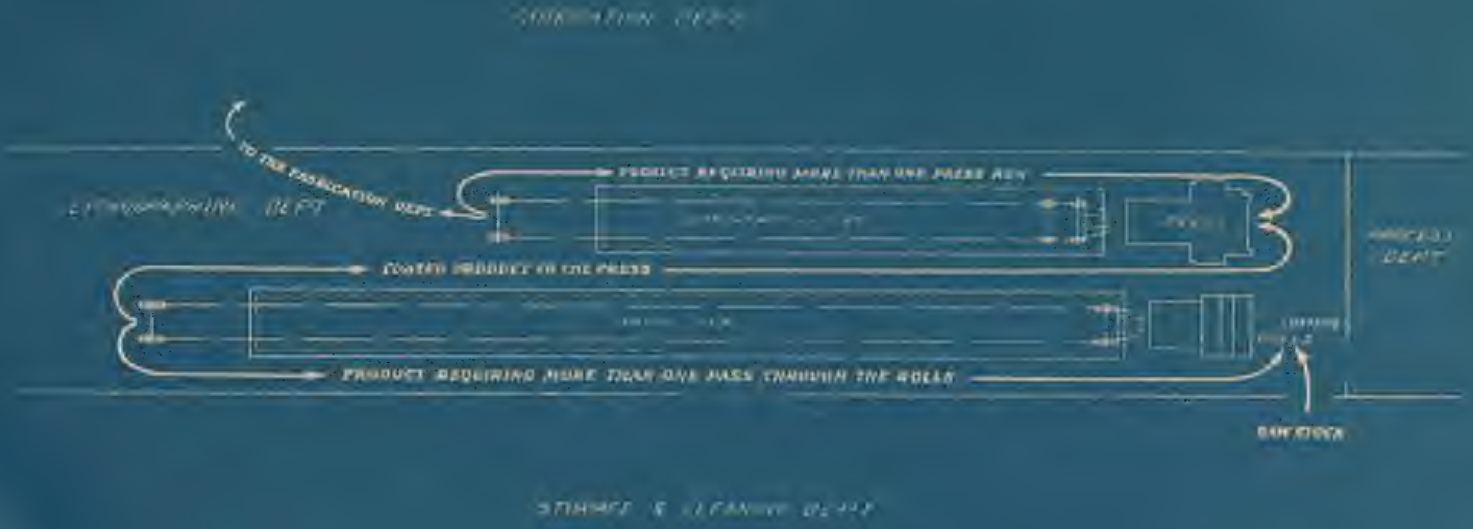
It is interesting to note also that the cooling system is so designed that an appreciable saving in heat is accomplished by diverting the bulk of the heated air back into the oven where it assists in reducing the heat required for the operation of the oven.

Sanitary Lacquer has become a very important material particularly in the marketing of canned goods. Such things as spinach, grape fruit, pumpkin, rhubarb, and so on, have a severe effect upon the tin which later results in such defects as chemical etching, pinholing and discoloration. All of these defects either cause the appearance of the product in the can to look questionable or they actually spoil it. Naturally, the better the lacquer coating that is used to offset these defects the less the loss of the food products will be before they are consumed. One of the hardest things to be overcome in the marketing of canned goods is the electrolytic action.

Sanitary lacquer is applied to the inside of the sheets that are later used in making cans, which means that the inside of nearly all cans containing food products is provided with this protective coating, carefully applied in an even coating.

Proper handling and baking after the sanitary lacquer is applied is one of the most important factors governing the successful marketing of these various materials that are now shipped in cans.

Corn Lacquer has recently come into prominence as a result of the efforts of canners and the United States government working together to eliminate the discoloration or blackening defect that


FABRICATION DEPT
LITHOGRAPHING DEPT
TO THE FABRICATION DEPT
PRODUCT REQUIRING MORE THAN ONE PRESS RUN
PRESS
PROCESS DEPT
COATED PRODUCT TO THE PRESS
COATING
PRODUCT REQUIRING MORE THAN ONE PASS THROUGH THE ROLLS
RAW STOCK
STORAGE & CLEANING DEPT

Color Plate IV.—A SUGGESTED LAYOUT FOR A LITHOGRAPHING DEPARTMENT

often occurs in canned corn. The proper coating material having been developed, there is only one thing left to do satisfactorily and that is its application.

Uniform heating and proper ventilation together with the correct period of time that the coated sheets are allowed to remain within the uniform temperature of the oven all contribute to the extermination of the defect mentioned. Obviously, this increases the need for and the use of continuous conveyor coating ovens.

A Typical Layout for lithographing (Color Plate IV) is instructive, for it shows how well this work has been organized to reduce labor and produce the finished part as near automatically as possible.

XX

WATER JAPAN

Water Japan
Facts
Additional Information
Fire Hazard Reports
The Electric-dip Method
The Hot-dip Method

Water Japan is a product of the Research Laboratory of the General Electric Company. Mr. Wheeler P. Davey, who discovered it, says:

> Water japan consists of an emulsion of japan base in water. By this is meant that an enormous number of tiny ultra-microscopic globules of japan base float around in the water japan in much the same way that globules of butter fat swim around in ordinary sweet cream. The diameter of the globules is about 0.000001 inch. The emulsion is permanent, showing no tendency to settle out even after several months. It may be strained in the same manner as ordinary japan and, if desired, may be cleaned in a commercial clarifier of proper design.
>
> Since water is the solvent the losses due to evaporation are negligible, especially if the japan is kept cool. Scum will not form on the surface if the temperature of the liquid is kept below 100 degrees F. (38 degrees C.). After the water japan is baked it is quite insoluble in water. The range of concentration which may be successfully used is very great so that little supervision is required.
>
> The viscosity of water japan is much less than that of the same base dissolved in kerosene or similar solvents. There is a possibility that, in the future, methods may be worked out by which the viscosity of water japan will be so adjusted that metal may be coated with water japan by dipping in the same way as with ordinary japan. However, the advantages of employing certain entirely different methods of applying the japan base to metal before baking seemed great enough to justify their development.
>
> They all have this feature in common—the japan base is deposited on the metal in a solvent-free condition. In this way, the behavior of the japan in the baking oven depends entirely on the characteristics of the japan base employed so that secondary drip is rendered negligible.

The great argument in favor of further research on water japan is the elimination of the fire risk, said to be present in ordinary baking japan. (At present the parts to be water-japanned must themselves first be heated.) However, fundamentally the final result is about the same as with ordinary baking japan since substantially the pigment only is left on the surface in both processes.

FACTS covering the use of this new compound such as the author has been able to gather are given below:

1. Water japan is shipped ready for use, but if shipped in quantity it would be at about 30% concentration. With 30% concentration, the japan should be thinned with distilled water to a 20% concentration, which is the proper concentration for its use. It is true that the customer saves a certain amount of freight on water.

   The water japan cannot be judged by a specific gravity but rather by percentage of concentration. The proper percentage of concentration in any particular case depends on the kind of work, the temperature at which it is to be dipped and baked, and whether the customer desires a thin or heavy coat. For a thin coat, baking at a temperature of 500 degrees F. a 10% concentration should be used, or probably anything from 10 to 15%.

   On the other hand, for a heavy coat, or where it is desired to apply several coats, a 20% concentration is recommended. If the concentration varies between 18 and 22% there would probably be no noticeable difference in the coat, but should the concentration go as low as 15% or as high as 25% it would be noticeable in the work turned out.

2. No agitation is necessary to keep the solution in the proper condition, as it is permanent and will not settle out. It is an advantage to keep a circulation up in the dipping tank since it keeps the surface of the liquid clean and allows for better cooling of the japan.

3. In one plant they get a coverage of 240 square feet per gallon with water japan, but they call the coverage 200 square feet and believe that this is a more conservative figure to use.

4. Water japan can be used for several coat work, but after numerous coats, less japan is added each time and after repeated bakes the earlier coats of japan would tend to become brittle. Some typewriter parts, which were done, look very fine indeed. These have five coats each. They were preheated to 575 degrees F. and baked at that temperature, the bake lasting 18 minutes, but this is a little higher temperature than would generally be used and therefore the time is somewhat shorter.

5. In handling the material in dipping baskets they usually use baskets with ½ inch mesh, and while with repeated dips the mesh filled in somewhat it does not tend to build up a very thick coat of japan for the reason stated above; that is, that less and less japan is added each time. After using the basket for a considerable length of time, the coat on the basket becomes brittle and it is then advisable to chip it off.

The secondary drip, when the japan gets into the oven, is practically negligible, when water japan is used and the possibility of runs is very much less than with ordinary japan.

For high-grade work, basket dipping is not recommended as there are liable to be small scars where the pieces touch and it is not a good method to imply where there are large flat surfaces which may get together. Basket dipping is recommended where a high grade of work is *not* required, as with small punchings, castings, and so forth.

6. The question of water japan involves a number of important questions as regards the method of handling the work; in the first place, the pieces must be heated, then dipped, allowed to drain, and then baked over again. Therefore, it is necessary in the case of a hand-loaded oven to have some sort of a scheme whereby a number of pieces may be taken from the oven at one time and dipped quickly. If the parts are light; that is, stampings or thin sheet-metal parts, they cool very quickly, so that there must be little time elapse between the time that they are taken from the oven and dipped into the water japan.

   Secondly, the parts must be immersed or soused into the japan quickly, because if this process is slow the heat will be drawn out of the part or piece being coated, so that the part last to enter the bath would not be coated as it should be.

7. It would appear that the water japan proposition will simmer down into some sort of a process whereby the parts may be handled either, for small production, by a reel type intermittent conveyor oven such as used in bread baking, or perhaps for the larger production, an overhead track mechanically dipped, or in a continuous conveyor oven. Inasmuch as the parts must be hot when they are dipped, equipment must be provided which will handle the heated parts quickly from the oven to the japan and which will not necessitate such frequent opening of the oven as would be the case with hand operation.

ADDITIONAL INFORMATION under date of January 1924, as given out by those who have been licensed to manufacture and sell this material is as follows:

A. Will adhere to all metals and metal finishes such as sherardizing, galvanizing, and so forth.
B. Will adhere to porcelain.
C. Will not sag from holes, which is one of the difficulties with the usual type of baking japan when used in dipping.
D. Will not run from edges, however sharp, if handled properly in dipping.
E. Will cover perfectly with one coat any article where the metal is not under 0.060 inches (No. 14 B & S gauge) when applied by the hot-dip method.

F. The average covering capacity determined at one of the plants of a large electrical manufacturing company on 400,000 pounds material of various kinds (castings, small parts, and so forth) show that an average of 480 pounds iron with an average of surface of 210 square feet are coated per gallon of the 22% concentration water japan.

It has been determined that water japan of 22% concentration will cover approximately 220 square feet sheet metal of 1/32, 1/16 and ⅛ inch thickness, one coat.

It has been determined that water japan of 22% concentration will cover approximately 150 square feet of rough castings, one coat.

From the above figures it will be found that one gallon of 33-1/3% concentration water japan, which is the concentration at which it is sold, will cover as an average 315 square feet of surface.

This compares very favorably with cheap, bright baking japan containing 50% gilsonite and linseed oil, and 50% of mineral turpentine substitute. This material when thinned three parts of japan to one part of benzine covers 305 square feet one coat on actual production.

G. The japan should be thinned to approximately 20% base concentration with distilled water. This water may be actually distilled, or may be secured by condensation of steam exhaust such as from radiators. It must be oil free. Water japan is sold at 33% base concentration. In order to get it to 20% concentration, to every 100 gallons of 33% base concentration (weight 833 pounds), there is added 65 gallons of distilled water (weight 542 pounds).

The exact concentration required depends somewhat on the type pieces to be japanned.

If pieces are very heavy, and therefore retain heat for a long time immersion in cold water japan, concentration can be less than for light pieces, as the thickness of the japan coat depends directly on temperature of immersion and heat capacity of the metals coated.

To test the concentration of water japan a 50 cc. of water japan is placed in a glass beaker. 5 to 10 cc. of 5% muriatic acid (hydrochloric acid) is slowly added with stirring. A glass rod is used for stirring. The muriatic acid coagulates the base from the water japan. It may then be easily collected on the stirring rod. The lump of base on the stirring rod is washed in water, kneaded in the hands first under water, then in the air to remove acid and water, and weighed. Doubling the weight in grams (decimal system) gives the percentage concentration. This whole test takes less than five minutes.

H. Water japan in tank should be kept cool, preferably under 60 degrees F. This can be done in several ways, but is best done by cooling coils and by blowing cold air through the japan.

I. Preheating burns off oil and helps to clean articles of dirt. Burning off the oil releases adhering dirt, and so forth. The work should be preheated to about 500 degrees F. It should always be over 450 degrees F. to insure removal of grease.

J. The article should be quickly immersed in the water japan. It is absolutely necessary for this to be done quickly, as otherwise edges will cool and then will not attract a sufficiently thick coat of japan.

K. Baking time and temperature is preferably for 15 minutes at 500 degrees F., although it may be baked for a shorter time at 600 degrees or a longer time at a lower temperature. The japan should be removed from the baking oven before it is hard, while at the temperature of the bake. If it is hard while still at 500, it is overbaked and will tend to be brittle. It should be just tacky while at 500. When cold, it will then be hard.

L. Electric preheaters and electric baking ovens are preferable as they give uniform heating and are better controlled than gas type of ovens.

M. The natural ventilation in the baking oven through a flue has been found to be sufficient to carry off the traces of water vapor and the slight amount of products evolved from the japan base itself during the baking process. No fan is required.

N. The relative freedom from drip which is a characteristic of water japan makes it unnecessary for long drainage between dripping and baking—only about 30 seconds being required. Also this prevents material on one bar from being marred by japan dropping from the next highest bar. This same property promotes cleanliness in and about the oven.

O. Due to the low viscosity of water japan dirt drops readily to the bottom of the dip tank. Each particle of any material which may fall into the tank at once settles to the bottom. The result is that, although water japan may be cleaned in a centrifugal clarifier or by filtering like other japans if desired, for most purposes it may be considered as self-cleaning. It is advisable, however, that the tank be emptied occasionally and the foreign matter at the bottom removed.

P. If a conveyor oven be already installed with no preheater, the baking oven can be used as the preheater, and the dipping tank located at the outlet end of the oven instead of at the inlet end. This will make the job partly intermittent, but makes a rather good layout along these lines. The conveyor may be strung with work and when the oven is full, but before the first work reaches the dip, the conveyor is stopped for a sufficient time to insure preheating. In some cases this is not necessary. The conveyor is then speeded up in order to pass the work through the dip quickly and the work is again allowed to pass through the oven for the short baking period when it can then be removed.

Q. One dipping method is to have the conveyor going at the rate of not less than six inches per second. This speed is determined by the necessity for having each portion of each piece of metal at a temperature of 400 degrees F. or more *at the instant* it enters the japan. The speed of dip must, therefore, be at least as great as the rate of travel of the cooling wave along the material, as it is submerged in the japan.

R. Another is to have the travel of the conveyor intermittent. When one rod or basket of articles comes out of the preheater, the conveyor stops and by mechanical means, the tank of water japan is raised sufficiently to submerge the articles hanging over it. (This method is covered by a patent application by the author.) A somewhat more expensive mechanical layout is required but the tank of water japan need only be small and contain very little water japan, while in the above water japan, the tank has to be quite wide. All hooks and baskets must be of steel.

S. The water japan dip tank should be an iron tank somewhat wider than the conveyor. It must not contain any other metal. At one end of this tank an iron partition runs from near the bottom to within two inches of the surface of the water japan. A set of cooling coils of iron pipe is placed behind this partition.
At the opposite end of the tank, and in the bottom are a number of air jets. The air used in the air jets passes through a scrubber which may consist of a 4 inch vertical pipe about 10 feet long in which there is about 18 inches of water. There is a baffle half way up. The air passes through the water, past the baffle and out on top. The water in the scrubber is changed daily.
In this way, the combined convection currents due to the air bubbles and the cooling coils keep the temperature of the japan always below 70 degrees F.

T. When the articles are small, the preheating oven can be divided into steel drawers, each drawer containing the articles either on a small rack or in baskets. When one drawer is removed from the oven, the rest of the articles in the oven will not cool off rapidly due to the fact that they are in the drawers.

Fire Hazard Reports on water japan by the Underwriters' Laboratories contain the following information:

> Water japan consists essentially of an emulsion of an asphaltic japan base in water. To be used by the manufacturer in japanning processes, enameling ovens, and so forth.
>
> The hazardous properties of the product are judged to be relatively small, the rate of hazard being between 0. and 10 as determined by Underwriters' Laboratories Schedule for classification, in which
>
> | | |
> |---|---|
> | Ether rates | 100 |
> | Gasoline rates | 90-100 |
> | Turpentine rates | 40-50 |
> | Kerosene rates | 30-40 |
> | Paraffine oil rates | 10-20 |
> | Water japan rates | 0-10 |
>
> Since water japan consists mostly of water, it was obvious that no flash point could be obtained, hence the test was only conducted on the water free base. The flash point of this was found to be 272 degrees C.

> No ignition point could be obtained in the finished product. The apparent ignition point of the water free asphaltic base was found to be 410 degrees C.
>
> It was not possible to ignite either the water japan or the water japan base by the small test flame.
>
> The fire hazard of water japan is judged to be very slight.

THE ELECTRIC-DIP METHOD of application is described by Wheeler P. Davey as follows:

> The electric-dip method is adapted to small odd jobs of japanning rather than to quantity production. The water japan is put in an iron tank which is connected to the negative terminal of a direct-current circuit. The metal to be coated is connected to the positive terminal of the circuit.
>
> Since the globules of base in the water japan carry negative charges, the base will be attracted to the positively charged metal. The water is left behind, so that the metal is covered with a thin film of japan base, free from solvent. This film possesses some insulating properties even before baking, so that as soon as the most exposed portions of the metal are coated, deposition starts in whatever holes and recesses may still be bare.
>
> The thickness of the deposit of base depends upon the product of the current-density and the time. Using a 125-volt circuit, the time required for a satisfactory coat is about 2½ seconds. In using the electric-dip method no special voltage is necessary. The work is connected directly across a direct-current line of high current carrying capacity without series resistance so that the current flowing will be proportional to the area to be covered. The current on 125 volts will average about 0.8 ampere per square inch of surface to be covered.
>
> Due to the polarization effect, the current is higher at the instant the circuit is closed than at the moment of breaking. Time is most conveniently measured by means of a time switch connected to a relay. Accidental short circuits are prevented by a wooden crating on the sides and bottom of the tank. It is absolutely necessary that the surface of the metal to be coated be free from grease or other insulating material. During the time the japan base is being deposited, the metal should be submerged at least two inches below the surface of the water japan so as to allow it to be in an approximately uniform electric field. Only one coat can be given by the electric-dip process as baked water japan acts as an insulator.

THE HOT-DIP METHOD of application is likewise described by Wheeler P. Davey as follows:

> The hot-dip method is adapted to work with large quantities of small castings, punchings, and so forth, where it is essential that the labor

cost be kept at a minimum. The metal to be japanned is placed in wire baskets and heated in an oven to a temperature of about 500 degrees F. (260 degrees C.). It is then cooled to about 400 degrees F. (200 degrees C.) and quickly plunged into the cold water japan. The japan base leaves the water and collects in a film on the surface of the metal.

After the basket has remained in the water japan about 10 seconds it is removed, drained for about 30 seconds, and placed in the baking oven, where it is baked in the usual manner. After baking the basket is emptied into storage boxes. The baskets may be handled entirely by chain-falls or an air-hoist so that upwards of 100 pounds of metal can be handled at once. Except when the pieces of metal to be coated are very small, reinforced baskets of ½ inch mesh wire screen are suitable.

The metal is often shoveled directly into these baskets, especially if it is in the form of small irregular castings or punchings. In some cases, however, it is advantageous to pack the contents of the basket systematically, either for the sake of getting in a greater number of large pieces or of determining where the points of contact from piece to piece shall be. There is no handling of the individual pieces from the time the basket is filled until it is finally emptied into the storage box.

Preheating was originally developed as a cheap method of cleaning grease and oil from metal before japanning. It is especially useful on steel punchings, and on brass, copper, and aluminum. Most grease of this sort is thoroughly cleaned off if the metal is heated to a temperature of 500 degrees F. (260 degrees C.) and kept there for half an hour. It was soon found that if this preheated metal was quickly plunged into water japan while still hot (250 to 400 degrees F.) that the heat in the metal had the same effect as the electricity in the electric-dip process in causing the japan base to adhere to the metal leaving the water behind. There was this additional advantage, that the surface of japan immediately in contact with the metal started to bake from the residual heat of the metal, thus tending to insure good adhesion.

In case the metal to be coated has flat faces, there is a chance that two flat faces may lie together so that neither of them would get a satisfactory coat. This may easily be obviated by dumping the hot contents of the basket into the water japan, catching the metal in another basket below.

Due to the fact that there is practically no *secondary drip* with water japan the scars due to contact of one piece with the edge of another in the basket are negligible. After baking, the baskets are usually emptied by turning them upside down. In case it is desired to give more than one coat of japan, the basket is taken out hot from the baking oven and at once dipped. It is then put back to be rebaked.

XXI

MECHANICAL DECORATION

Imitation Carving
Production Short-cuts
Wall Panels
The Mirror Sign
Paper Stencils
Cutting the Design
To Remove the Stencil Parts
Protective Surface Compound
Composition Stencil Material
Preparing the Stencil
Applying the Stencil
Laying Out the Design
Keeping the Stencil in Condition
Uses of the Flexible Stencil
Incised Letters and Designs
Raised Letters and Designs
The Liquid Stencil Process
A Single Thickness of Composition Sheet Stencil
In Making Signs
Delicate Panel Effects
If the Composition Stencil Should Harden
The Pouring Method
In Using the Sand-blast
The Ideal Sand-blast Installation
Lacquered Signs
Plate Glass Pictures

Imitation Carving is now made possible and simple. The possibility of now making letters and designs in the third dimension opens up an entirely new field of endeavor for those who are willing to take advantage of it. To think that a glass picture could be made mechanically in a very short time is little short of marvelous.

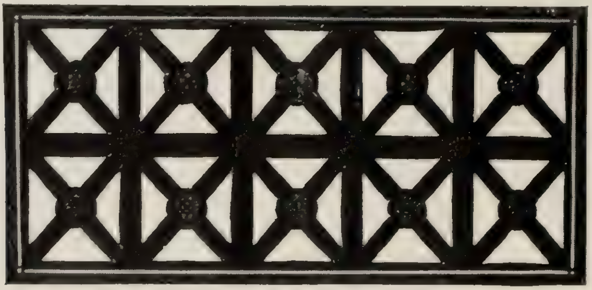
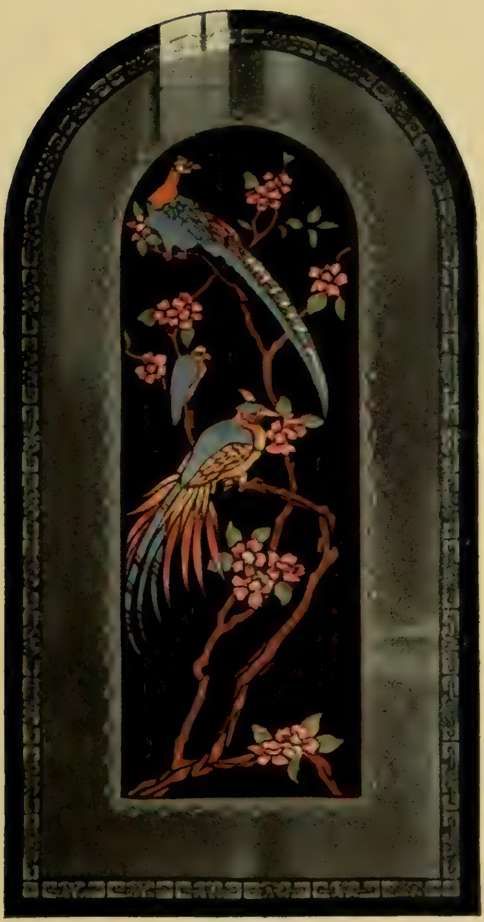


Figure 131—A Penetrated Panel

Here is illustrated (Figure 131) a black composition material similar to plate glass that has been sand-blasted clear through the thickness of the material which in this case is ½ inch!

Production Short-cuts reduce the time required to do a certain job and thus lower costs and increase the demand for the article.



Color Plate V.— A Sand-Blasted Wall Panel

A trio consisting of the sand-blast, the spray-gun and the composition stencil make a combination having unlimited possibilities in this regard. So important is this matter that publication of this book was held to get this information in so that its readers might be among the first to learn the facts relating to these new developments and profit accordingly. The japanner who owns a sand-blast equipment naturally desires to keep it busy and a close study of the information in this chapter as well as detail descriptive information in Chapter IX on Sand-blasting and in Chapter XI on Spraying Equipment will open up a new field for the fulfilment of such a desire.

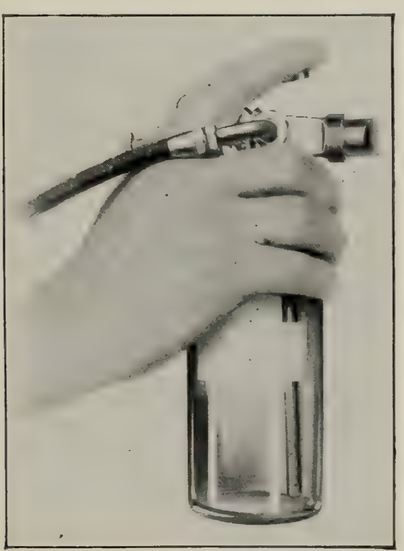


Figure 132—The Touch-up Spray-gun

Wall Panels made of composition material in various colors are indicative of some of the things that may be expected in the future in the advancement of the art of mechanical decoration. In Color Plate V a beautiful jet black panel which is 24 inches wide, 46 inches high and ½ inch thick is shown. It is made from a high-class composition material which combines the qualities of glass, marble and porcelain. The reflections in the illustration show what a high polish, even in black will do. The border designs are made by sand-blasting the black material lightly. The Chinese pheasants, which are colored in tints of blue, red and yellow, are first sand-carved and then decorated with a touch-up spray gun (Figure 132), also a modern development.

The Mirror Sign (Figure 133) is a good item to use as an illustration for it has become popular from one end of the country to the other for advertising purposes. It consists of a mirror mounted at an angle of 45 degrees in a metal support and a transparent glass sign installed horizontally directly above the mirror. The sun amplifies the visibility of this type of sign, but even dull daylight serves well to make it attract attention.

Perhaps if the reader will stop a moment to look out the window as he reads this paragraph he will see a motor truck pass by equipped with one of these very simple and ingenious signs.

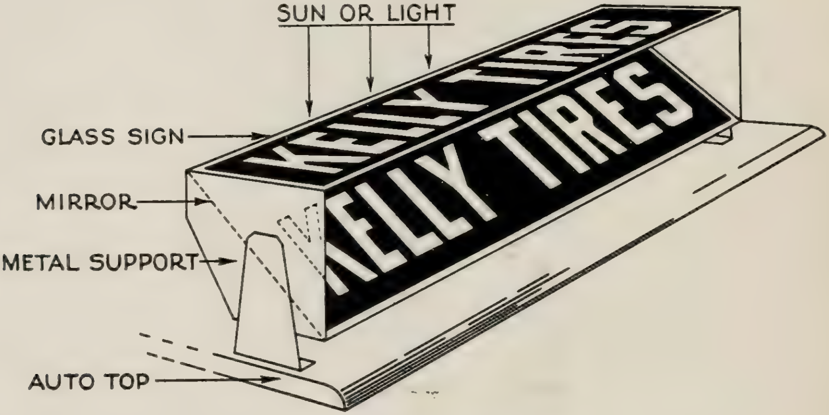


Figure 133—The Mirror Sign

I have it on fairly good authority that the inventor of the idea allowed the time limit for making a patent application to lapse and thus lost his rights to exclusive use of the idea. If this is true it means that anyone who so desires may make them. The criticism of the designs that have appeared so far is crudeness. Mechanical decoration will overcome this and we may look for some very fine and attractive signs of this type in the future, some of them perhaps approaching the quality of work shown in the last color plate.

Since the sand-blast may be used in making letters, figures and designs that are either positive or negative, male or female, left hand or right hand, there is only lacking the part-time artist who can make the lay-out and a search for him will uncover more than enough to supply the demand. This artist will make a design, not on a regular drawing paper but on a strange new material that may be generally referred to as a sheet of protective composition—a very descriptive and appropriate name for it protects the covered surfaces of the glass, wood or metal, that are later to be the finished sign, against the terrible bombardment of the mechanically produced sandstorm that strikes only where the surface is exposed.

Paper Stencils are hard to cut. I wonder how many readers have actually tried to cut a stencil made of heavy paper? Well, be prepared for a pleasant surprise for the composition sheet cuts as easy as *butter!* They are made of a glue compound and may be purchased in black, opaque or transparent form. Glycerine and zinc oxide are also used in the manufacture of some of these stencil compounds.

Cutting the Design that is to finally appear after it has first been drawn is accomplished with an ordinary stencil knife. Clean, strong strokes of the knife should be used. Care should be taken to make sharp, square corners. Be sure that the stencil knife is sharp so that a cut clear through may be made at one draw of the blade. If this be done, there will be no ragged edges. A sharp knife will pass through even a double thickness of the composition stencil material with nearly as much ease as that experienced in drawing a pencil over the surface. The knife should be held vertically.

To Remove the Stencil Parts, raise those that are to expose the surface that is to be sand-blasted with a pointed tool. It may be necessary to go over some of the corners and angles that have not been clearly cut with the stencil knife in order to bring them up to standard. Applying a heated knife blade to the underside of the stencil may be necessary in some cases.

Protective Surface Compound is similar to the parting sand used in foundry work. When sprinkled on the doubtful surface it eliminates moisture and tackiness. It is especially valuable in hot humid weather to condition the composition material for use.

Composition Stencil Material[1] is very new in the market yet some important specifications have been developed to cover it as follows:

1. It must have the stretch and life of live rubber.
2. It must be made to suit the climate—one formula for hot areas and another for cold, dry or damp areas.
3. It must be protected before use or while in the storeroom against drying out or becoming brittle.
4. It must stick fast when applied to the surface and must be easy to remove.
5. It must be easy to melt, but must not give way to the heat created in the sand bombardment.
6. It must not run or become liquid while in use.
7. It must not stain the surface to which it is applied.

There is no waste on this composition material for it may be used over and over again. When the sheet form has served its purpose both the pieces that are cut away and those that remain in the surface to protect may be thrown into a double boiler and melted into the hot material which is poured on the surface that is to be protected. This has a special use, for example, on blank surfaces where no lettering or design appears.

One form of manufactured sheet is shipped with a fine tissue paper protection on one side. This is removed by moistening before sand-blasting is begun. Should the material in this operation become tacky or sticky and too resilient for easy and quick cutting with the sand-blast this may be corrected with a powder specially made for the purpose. The sheet material is marketed in thicknesses of about 1/16 inch and weighs about three and one-half pounds per square yard.

Preparing the Stencil so that the sand-blasting operation may proceed without interruption is important. It should have the compressibility of an uninflated automobile inner tube. This condition can be secured either by the use of the protective surface compound or water. Hot water is used in cold weather and cold water in warm weather.

Applying the Stencil, after making sure that the surface is not too hot or too cold, is a very simple matter. When sheet compound having a paper backing is used, lay the paper back down and with a good sized sponge (Figure 134) apply water to the other side until the material is quite tacky. This may be determined by feeling with one finger.

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[1] Compare this with the masking tape described in Volume II, Chapter VI.

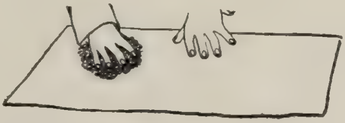

Figure 134—Moistening the Stencil

Next, turn the sheet over, leaving a little projecting over the edge and roll (Figure 135) out smooth to remove the air from underneath. It is best to work from the center outward when using the roll.

You are now ready to remove the paper that is sent out, only as a protection for the material in shipment and handling before use.

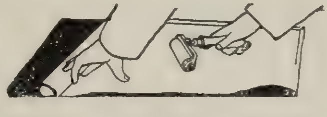

Figure 135—Rolling the Stencil

This is done by wetting the paper with cold water and peeling it off. Use protective surface compound to harden the surface if necessary.

Laying Out the Design (Figure 136), whether it be a sign or a fancy layout having scrolls and figures, is done directly on the surface thus prepared using an ordinary draughtsman's tee-square or straight edge and triangle.

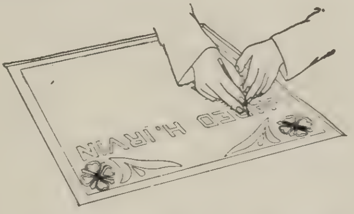

Figure 136—Laying Out the Design

Where duplicates are to be made from a special drawing made by an expert all that one need do is to lay a sheet of carbon paper on top of the prepared surface and trace over the original drawing to transfer the carbon impression to the surface. Thus the original drawing may be used over and over again. Another method is to turn the carbon paper face up when the drawing is originally made so as to transfer the carbon ink to the back of the original drawing. Then when the drawing is traced the design will be transferred to the composition material.

Should it happen that no carbon paper is available the back of any drawing may be dusted with Venetian red dry color which may be purchased at any paint store and the operation continued as above suggested.

Keeping the Stencil in Condition before use is important because of the varying weather conditions. It is hydroscopic in that it takes up moisture. For these reasons it is best to keep the stencil material in a special humidor made for the purpose until such time as manufacturers can develop a better process of handling.

Uses of the Flexible Stencil are unlimited. Already it has served well on steel, wood, brass, stone, glass and special material compositions. While the idea is very new and time has not been allowed to develop color combinations very extensively, there have been some very beautiful glass table tops, redwood panels and plate glass pictures made. Due to the fact that the depth of the cut may be varied this opens up a new field for art which may be described as the reverse of oil painting in which the material is raised away from the canvas backing to get various effects.

Incised Letters and Designs may be easily produced by this system. In fact, any cut glass design that was very laboriously made by hand grinding or carving may now be produced quickly and cheaply by this new process in which the power behind the artificial sand storm is supreme. It is best to keep the sand-blast nozzle blowing straight into the design while moving it regularly back and forth to get an even effect as well as a uniform depth.

V-shaped incised letters or those with rounded forms, technically called U-shaped, can be made at will by means of the sand-blast. The only real difference is that in the U-shaped letters the cut is made a little deeper. It has been erroneously stated that the sand-blast will not cut a V-shaped letter.

Raised Letters and Designs may be made the reverse of the incised method. All one need do is to remove the part of the composition stencil that covers the *background* leaving covered the parts that are to appear raised in the final product. The background may be treated in many ways with varying degrees of sand-blasting at various depths and suitably colored.

The Liquid Stencil Process is a crude form of using the stenciling idea described herein. It has the disadvantage of requiring from 24 to 48 hours to dry and get in condition for receiving the design and acquiring the proper set to resist the bombardment of the sand-blast. Also, it is difficult to recondition after it becomes set on the surface and that means that the work of blasting must be done when the material gets in condition as a delay may mean hardening and ineffective protection to the surface.

A Single Thickness of Composition Sheet Stencil may be used where the cutting does not exceed ¼ inch. Where conditions require deeper cuts more thickness must be used.

In Making Signs and other products it is possible to buy sets of standard metal letters. These may be laid out on the composition stencil and the background sprayed with paint or lacquer to outline the letters. The letters may then be removed and used again at some future time after which the cutting of the stencil may proceed. Truly, there is no further excuse for poor signs with this easy mechanical method now available.

Delicate Panel Effects may be secured by the use of different abrasives. For example, suppose sand is used in the general design and it is desired to have the panel a little darker, all one need do is to switch to a steel abrasive for the panel. It will be a delicate touch and the method used in accomplishing it will call for many theories by interested observers.

If the Composition Stencil Should Harden so that parts of it adhere too tenaciously the trouble may be immediately cured by soaking with warm water.

The Pouring Method of applying the composition stencil has been superseded by the modern and more efficient method of using manufactured composition sheets. For this reason the description of it is omitted from this book.

In Using the Sand-blast the operator should work on the whole design at one time in order to make a uniform job. The sand-blast gun which should be held a uniform distance from the surface of from 12 inches to 18 inches, depending upon the size of the nozzle, will insure cutting characters uniformly. The closer the nozzle is held to the work, the faster it should be moved. This is done to prevent burning the composition stencil. If spots appear that is a danger signal that the gun has played too long on one spot.

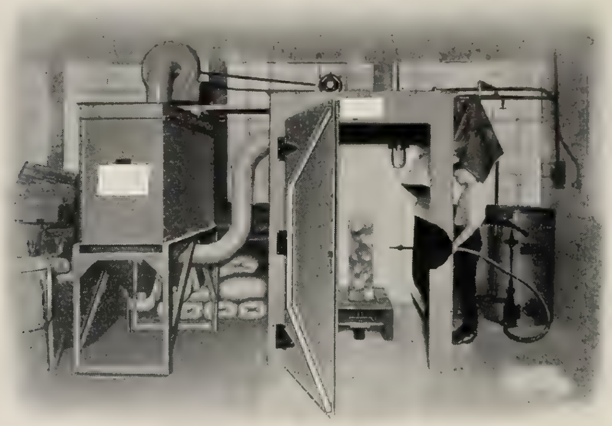

Figure 137—A Complete Sand-blast Equipment

The Ideal Sand-blast Installation consists of the items shown in Figure 137. These may be detailed as follows:

1. Direct pressure type sand-blast.
2. Steel room in which the work is done—it may be purchased at a lower price than a wooden one can be constructed.
3. Flexible curtain through which sand-blast nozzle is projected and moved back and forth at the will of the operator.
4. Canopy to protect eyes of workman so he can see work inside of closed sand-blast room.
5. Dust arrester which removes all ineffective abrasive from the steel room and collects it on the cloth plates enclosed in the metal cabinet shown at the right thus preventing contamination of the outside atmosphere.

6. The air compressor and air tank may be located either in the same space with the rest of the sand-blast equipment or in some other more convenient part of the shop.

Lacquered Signs may be applied over a lacquered background with the use of composition sheet stencils. In other words, what has been said above regarding sand-blasting may apply to the use of lacquer as well with the difference that the sign will appear above the face of the surface rather than below it.

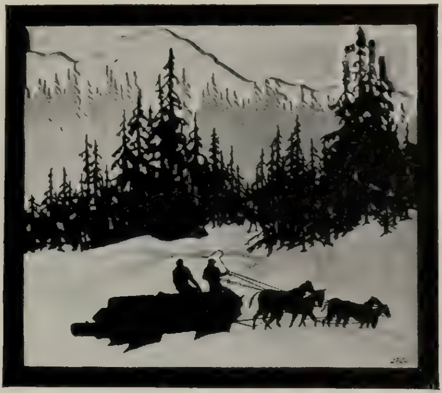

Figure 138—A Mechanically-made Glass Picture

Plate Glass Pictures (Figure 138) are the latest artistic development of mechanical decoration. By varying the depth of the sand-blast cut in the ¼ inch thickness of the plate glass some very interesting effects are obtained.

This is a new form of art which promises to be quite popular in the near future.

XXII

THE SILK SCREEN STENCIL PROCESS

- Uses
- The Process in a Nutshell
- The Silk Screen
- The Squeegee
- Methods of Filling the Stencil
- In Using the Portable Stencil
- Other Important Directions
- Parts May Be Oven Baked
- Spray-Guns

Here is another new idea that has great possibilities for the job finishing shop. What was said in the last chapter regarding artist's layouts also applies to this process. Once the drawing covering the proposed design is in hand it is only a few short steps to a highly commendable looking and pleasing result.

Uses have been found for this process in many lines. The trade marks of many automobile manufacturers have been reproduced in design as well as color. Furniture manufacturers have used it in ornamentation and in applying decorative designs on card tables and the like. Others have used it on cloth and felt textiles. Perhaps its greatest use has been in the making of advertising posters.

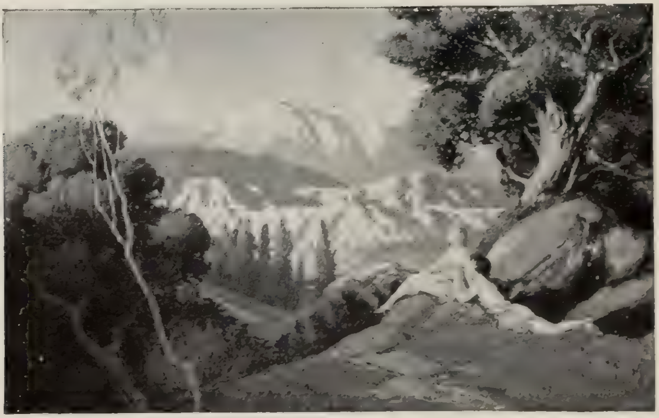

Figure 139—A Silk Screen Reproduction

A fine example of what may be accomplished is illustrated in Figure 139 which is a photograph of a reproduction by the process. This is an imitation oil painting even to the raised contour of the surface.

The field has lately extended to use on glass windows directly without any other background. Wooden real estate signs have been made by this process and, of course, there is no reason why the idea cannot also be used on japanned or enameled sheet metal. Other items such as vacuum cleaner bags, tire covers, mail bags, cloth pennants, rain bags and so on are regularly stenciled by this process.

The Process in a Nutshell consists of a screen, a squeegee, a fixture to hold the stencil and the use of some specially prepared oil paste paint. A special lacquer that will work in this process has even been perfected!

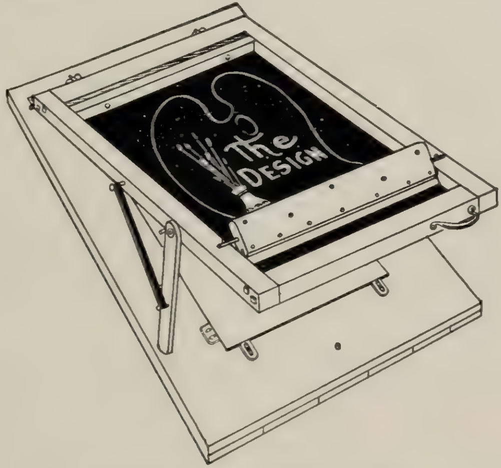

Figure 140—A Hinged Silk Stencil

There are two general methods of handling—first, on a flat or horizontal table to which is attached with hinges, the frame which carries the stencil; second, a small portable frame which carries the stencil and which may be used in a vertical position, for example, on the foot of a bedstead if desired. The latter is also used in applying advertising signs to show windows, many of which are used by chain stores.

The illustration herewith (Figure 140) shows a silk stencil that is all ready to operate. The screen has been fastened to the lower side of the swinging frame. The card that is to receive the design is in place on the flat bed underneath and registered similar to the method used to do this in a printing press. The supporting brace will next be turned up out of the way and the hinged screen dropped down on top of the card. The squeegee will then be passed over the stencil. This will force the special paint through the open pores of the screen and on to the card. The stencil will then be raised by means of the handle at the right.

Here only one color is planned, but should another or several others for that matter be used, there will have to be a separate stencil for each color and as many operations through the stencil as there are colors. Often the color of the background of the stock supplies one of the colors and saves a stenciling operation.

THE SILK SCREEN is in a way a misnomer, for other materials such as copper, bolting cloth and so on having either a fine or a coarse mesh are sometimes used. The cloth is the heart of the process and whatever attention is given to making it perfect will be rewarded in the final product. The cost of the silk runs according to the strength of the threads and the uniformity and fineness of the mesh. One grade is used for paper and celluloid stencils, another on sign cloth, felt and glass, and still another for letters smaller than 1½ inches. A special grade is used when it becomes necessary to reproduce a great amount of fine detail such as in photographic stencils.

THE SQUEEGEE (Figure 141) is the tool that forces the special paint through the small pores of the silk screen. The little pins on its ends ride on the frame of the stencil and prevent its handle from falling into the paint inside the frame. The handle is made of wood and is slotted to take the squeegee rubber proper. This must be a special rubber that will resist the action of the solvents used in the paint. Its end must be kept sharp since the sharp corners of the squeegee are really the parts that do the work of forcing the mate-

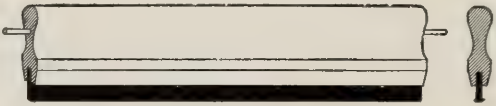

Figure 141—A SILK STENCIL SQUEEGEE

rial into the pores of the screen. This is done by rubbing the end of the squeegee on a piece of garnet cloth[1] tacked to the bench.

Methods of Filling the Stencil to block out the portions of it that are not to print are several. First, the silk must be carefully stretched taut on the frame and then washed with warm water. After it is dry a material must be used as a filler that will not be affected by the solvents in the paint or by the cleaning materials used afterward. The three principal methods are as follows:

1. A special filler made for the purpose is used. It is applied with a soft brush after the design has been drawn directly on the silk with a hard, sharp lead pencil.

2. The face of the paper carrying the design is given two coats of pure shellac and allowed to dry. The letters or design are cut out with a stencil knife. The remaining portion of the paper drawing is placed on the bottom of the silk covered frame and properly located. (To accomplish this the frame must be turned upside down.)

   Pass rapidly over the unshellaced side of the paper with a small, hot flat iron. This will cause the shellac to melt and flow into the pores of the silk and thus make the paper adhere firmly.

3. Instead of using the paper referred to in the preceding paragraph, make the design on sheet celluloid. Place the silk covered frame on top of that portion of the celluloid sheet remaining after the letters are cut out and moisten the silk with a solvent of celluloid. This will cause the silk and the celluloid to combine tenaciously.

Finally, run a sealer strip around the inside of the stencil to seal the space between it and the wooden frame.

In Using the Portable Stencil where two or more colors are used it is well to place an extra small hole in the design that will be common to all stencils used in that particular design. The spot made by it will act as a key to properly register the colors that follow.

Other Important Directions to aid the use of this process are listed as follows:

1. Use about a pint of special paste material in the stencil frame. Tilt the handle of the squeegee in the direction the squeegee is moving. Keep the paint material *ahead* of the squeegee.

---

[1] See Volume II, Chapter VII, for further information.

2. Use a double stroke on the first impression and a single one after that on all other impressions.
3. There is no limit to the speed that may be used. It is common practice to make 350 impressions per hour.
4. *Never allow a silk stencil to stand unused for more than 20 minutes.* Wash when necessary with either benzine or turpentine. Never use kerosene.
5. When through with a stencil remove the blocking out material with a suitable solvent and apply another design the same as if a new piece of silk were being used. Omit the warm washing operation, however.
6. Allow the work to dry in suitable racks overnight.
7. To make a heavy embossed effect use thicker material.
8. The correct consistency of the paste paint may be determined empirically by tilting the screen at an angle of 35 degrees. If the paint moves slowly downward and does not penetrate the pores of the silk it is all right.
9. The base or table must be *perfectly level* to secure good work.

PARTS MAY BE OVEN BAKED the same as any japanned or enameled parts. Colors are usually dried in about three hours at 170 degrees F. They should be left in the oven overnight, if possible.

SPRAY-GUNS are used in connection with silk screen stencils to obtain delicate tints and shades in color as well as to camouflage the process by an extra operation after the stencil work is completed and before the job is shipped. A touch-up gun such as that mentioned in the preceding chapter is an excellent one to use.

Inclosed find $________ for which please send to the address given below—

1. Practical Color Simplified (Volume I, of the Practical Finishing Series) which includes the Finishing Research Color Chart in 25 colors (price $3.50).

or

2. Practical Automotive Lacquering (Volume II, of the Practical Finishing Series) (price $3.50).

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